INDEXED.

International Marine Engineering

JUNE, 1912

Twelfth International Congress of Navigation

The Twelfth International Congress of Navigation was opened Thursday morning, May 23, in the Metropolitan Opera House, Philadelphia, Pa., by President Taft. Hon. J. Hampton Moore, president of the local organization commission of the Congress, presided at the opening exercises, where addresses were delivered by President Taft, Governor Tener, Mayor Blankenburg, Brig.-Gen. Bixby and Prof. V. E. de Timonoff.

After the opening exercises the regular sessions of the Congress began on Thursday afternoon at the Bellevue-Stratford Hotel. The work was divided into two sections—Inland Navigation and Ocean Navigation—the meetings of both sections being carried on simultaneously.

The Twelfth Congress of Navigation was organized by the International Association of Navigation Congresses, having its permanent headquarters in Brussels, Belgium, and governed by a commission composed of delegates appointed by the governments of the States contributing to the support of the association. The permanent International Commission, as now organized, is made up of three executive officers, namely, two presidents and a general secretary, who are Belgians; seven gentlemen who have acted as general secretaries of previous Congresses, and eighty-nine members appointed officially by the several governments that support the association. The members of the Commission include, particularly in the great continental countries of Europe, the highest authorities in each country on questions connected with the planning, construction and operation of works for the improvement of inland and ocean navigation. The members from the countries which originally formed the association have been, in general, active participants in all the Congresses of Navigation since 1885, and the present permanent organization of the association is due to them.

The object of the association is to promote the progress of inland and ocean navigation by keeping its members informed regarding the most recent experience in the construction of great public works for navigation and the technical improvements in these works, and by discussion of plans concerning all important questions bearing on technique or a policy directly connected with such works. It accomplishes this object by organizing navigation congresses; by publishing papers, proceedings and various other documents, and by acting as an international bureau of information through which members may obtain the most recent information on all subjects connected with navigation works. International Congresses of Navigation have been held at various intervals since 1885 in Belgium, Germany, Austria, England, France, Holland, Italy and Russia. These congresses have been of the utmost value in furthering the general progress of work in the interest of navigation, and in studying the results of experience in the constantly arising theoretical and practical questions connected with waterway construction and with the technical, industrial and commercial development of inland waterways and sea ports.

For discussion at the Twelfth International Congress of Navigation three subjects were chosen for each of the two sections. Individual papers on these subjects were prepared by experts from nearly every maritime country in the world. These papers are published in full in the proceedings of the society, but before publication they were submitted to a reviewer or general reporter appointed for each question, whose duty it was to present an analysis of all the papers transmitted to him, giving his own views and personal opinion regarding the subject and drawing up a conclusion to be voted on at the Congress. These reviews are translated and printed in three different languages, and are distributed to the members of the Congress. In the following we give abstracts of the reviews presented before the Congress by the general reporters, together with abstracts of the summaries formulated by the general reporters in analyzing the communications submitted on the various subjects selected for each session of the Congress:

1st Section: Inland Navigation

1st Question: Improvement of Rivers by Regulation and Dredging and, if needs be, by Reservoirs—Determination of the Cases in which it is Preferable to Resort to Such Works rather than to Canalization or the Construction of a Lateral Canal

LIBRARY JUN 4 1912

GENERAL REPORT BY HENRY C. NEWCOMER*

Ten papers have been submitted on this question, as follows:

No. 2, Herr Geheimer Oberbaurat Dr. Ing. Sympher, Wilhelmstrasse, 80 Berlin W. 66.

No. 3, Mr. E. Lauda, Diplomierter Ingenieur, Sektionschef im K. K. Ministerium für öffentliche Arbeiten in Wien.

No. 3 bis, Mr. Bohuslav Müller, Ingénieur en chef du Gouvernement Imp. et Royal de Bohême, attaché à la Commission pour la canalisation de la Vltava et de l'Elbe en Bohême, Prague.

No. 4, Major Wm. W. Harts, Corps of Engineers, U. S. Army, Customhouse, Nashville, Tenn.

No. 5, Mr. Wm. B. Landreth, Civil Engineer, formerly Special Deputy State Engineer, 20, Gillespie Street, Schenectady, N. Y.

No. 6, Mr. Kauffmann, Chief Engineer of the Ponts et Chaussées, rue Dugommier, 9, Nantes.

No. 8, Mr. Eugene de Kvassay, Ministerial Counsellor, Chief of the Hungarian State Water Survey.

No. 9, Mr. Charles Valentini, Chief Engineer of the Genio Civile, at Bologna.

No. 10, Mr. R. H. Gockinga, Chief Engineer of Waterstaat, at the Hague, and Messrs. H. Baucke, E. Van Konynenburg and Jonkheer C. W. Van Panhuys, Engineers of the Waterstaat at Nimegen, Maestricht and Zutphen.

No. 11, Mr. V. E. de Timonoff, Professor at the Imperial Institute of Lines of Communication, Director of Statistics and Cartography of the Lines of Communication, etc., 7 Perspective Ismailovsky, Saint-Petersburg, and Mr. G. H. Kleiber, Engineer of Lines of Communication, in charge of dredging, Stoliarny, 11, Saint-Petersburg.

This question opens up a very wide field for discussion. Its full treatment would require a detailed account of all the methods of river improvement as applied either singly or in combination to streams of different characteristics, showing the advantages and defects of each type, the limits of its application, and the physical and commercial conditions that determine the choice of methods under different circumstances. Such an elaborate investigation is obviously impracticable within the brief limits of a report, and the reporter must therefore confine himself to a very condensed statement upon the general subject or direct his attention to a more detailed examination of some features that may be of special interest to him.

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It is quite apparent that no single method of improving the navigability of rivers is generally accepted as having merit superior to the others. While conditions in one country give special prominence to one method, the situation in another country leads to different results. In some cases increased navigation facilities can be supplied in several ways, while in others any adequate improvement is practically limited to one form of procedure.

It is believed that more emphasis should be placed upon the financial side of the problem. Usually the improvement that it is physically possible to make varies through a wide range, depending not only on the method employed, but also on the amount that can be expended, and it is necessary to determine the cost that is best proportioned to the commercial benefits. As the waterway problem is essentially one of transportation, it may even be advisable in some cases to inquire whether the commercial needs may not be best satisfied by railroad construction. This consideration would, of course, apply with greatest force in those instances where the authorities or parties conducting the investigation are in a position to provide whichever form of transportation is deemed most desirable.

It may be of some interest to refer to the results of investigations made a few years ago concerning the improvement of the Ohio and Mississippi Rivers by dredging. The Ohio River was examined with a view to its improvement by canalization to secure depths of 6 or 9 feet, and also to determine whether these depths could be maintained by dredging in the lower part of the river, for a distance of about 190 miles, from Green River to Cairo, where there is a slope of about 3.7 inches per mile. The conclusion was reached that either 6 or 9 feet could be maintained by dredging, and that the dredging would cost about 38 percent less than canalization for a depth of 6 feet, and about 60 percent more than canalization for a depth of 9 feet. The improvement of the Ohio by storage reservoirs has also received some consideration, and it has been ascertained that the entire run-off at Pittsburg, if completely controlled, could not give the desired depth of 9 feet, as the mean annual discharge corresponds to a less depth than this.

It is well known that a depth of 9 feet has been maintained by dredging in the Mississippi River below Cairo for a number of years, with occasional slight exceptions. Above Cairo to St. Louis the project provides for a depth of 8 feet to be obtained by dredging and regulation. The agitation for a deep waterway from Lake Michigan to the Gulf of Mexico led to an investigation of the practicability of securing a depth of 14 feet in the Mississippi River below St. Louis. All methods of improvement were considered, and Mr. Landreth has given the adverse conclusions reached with reference to the use of reservoirs. The Board of Engineers that conducted the investigation decided that dredging could maintain a depth of 14 feet below Cairo and St. Louis. The estimated costs, however, ran very high, being about $12,300 (£2,500) per mile per year above Cairo and $3,100 (£630) per mile per year below Cairo.

The divergence of views expressed, especially on the subject of dredging, makes it doubtful whether any conclusions can be framed that will meet with general approval in all respects, but the following propositions are submitted for the action of the Congress:

1. Under the widely varying requirements of navigation, and the very different physical conditions of slope, discharge and nature of bed, no single method of improving the navigability of a river has superior advantages in all cases, but each may in turn be found most satisfactory under special conditions.

2. The choice of a method of improvement depends not only on the capacity of the stream for improvement by the different methods, but also on the volume of commerce to be benefited and the resulting cost of transportation, including interest on the cost of improvement, maintenance charges and the cost of carriage.

3. The slope, discharge and nature of bed and banks are the main factors determining the limits and the cost of improvement by the ordinary methods of regulation, dredging and canalization, and the prospective tonnage is the main factor determining the justifiable expenditure.

4. Regulation and dredging, either singly or in combination, are apt to be more uncertain and limited in their results than canalization, but they are usually preferable when the needs of navigation can be satisfied by these means. Otherwise it is generally advisable to employ canalization, using fixed or movable dams, depending upon the limitations imposed by flood conditions, and the requirements of navigation.

5. Lateral canals are usually less desirable than canalization, but may be required under some conditions.

6. Reservoir control of stream flow, sufficient to meet the needs of navigation, is usually impracticable within reasonable limits of cost, but in rare cases it may be used to advantage to supplement other methods of improvement.

7. It is desirable that the following steps be taken with a view to perfecting the methods employed for improving the navigability of rivers:

(*a*) That scientifically organized special studies be undertaken by sundry nations, on rivers with different regimens, in order to observe the degree of navigability which it is possible to attain by the application of various methods of improvement and to determine the factors which govern the cost of the corresponding works.

(*b*) That hydrotechnic laboratories intended for the study, on small-scale models, of the life of rivers becomes of more and more extended use, and that they be supplied with the means necessary to experiment with the various processes for improving the navigability of rivers and, in so far as possible, in connection with the studies and works carried out on the rivers themselves.

(*c*) That the resolution of the Sixth Congress of Inland Navigation, voted at The Hague in 1904, be carried into effect, this resoultion calling for taking up, in connection with rivers having but one current, the study of a short, clear formulary, which shall be sufficiently complete and include the information necessary to define the characteristics of every river studied, from the double point of view of its regimen and its navigation.

(*d*) That the question of the improvement of the navigability of rivers having but one current, completed by those of the laboratory experiments and of the formulary, be kept on the order of business of the next Congress of Navigation.

21 Question: Dimensions to be Assigned, in Any Given Country, to Canals of Heavy Traffic—Principles of Operating—Dimensions and Equipment of the Locks

GENERAL REPORT BY ALFRED NOBLE*

Seven reports have been submitted on these subjects, presenting the results of investigations and of experience in several countries; arranged in their numerical order they are:

No. 13. In Germany, by Herr Geheimer Oberbaurat W. Germelmann.
No. 14. In Belgium, by Mr. P. Glaudot, Engineer of the Ponts et Chaussées.
No. 15. In the United States, by Col. H. F. Hodges, Corps of Engineers, U. S. A., Asst. Chief Engineer, Isthmian Canal Commission.
No. 16. In France, by Mr. J. Bourgougnon, Chief Engineer of the Ponts et Chaussées.
No. 18. In Italy, by Mr. Edmond Sanjust di Teulada, Senior Inspector of the Genio Civile.
No. 19. In Russia, by Mr. Nestor Pouzyrevsky, Engineer.
No. 20. In Sweden, by Col. Frederick V. Hansen, Corps of the Ponts et Chaussées, President of the Royal Administration of Hydraulic Motive Powers.

From the reports which have been briefly reviewed it appears that in Germany the cross-sections of canals have been

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fixed mainly with reference to boats having carrying capacities of 400 or 600 tons, these boats having the same cross-sections and differing only in length; the tendency, however, is manifest to provide for larger boats in certain cases, where connection is made with river traffic in which larger boats are used. The least wet cross-section is from 4¼ to 6½ times the immersed section of the standard 600-ton boat, and will permit such boats to pass each other anywhere; a clearance of 2½ feet or more is allowed between the keel of the boat and canal bottom when the canals are built. In Belgium the canals in the vicinity of the large industrial centers and their connections to tide water are being enlarged, or are to be enlarged, to pass boats of 1,000 or 2,000 tons capacity; but farther into the interior toward the French frontier, dimensions suitable for 300-ton boats are to remain standard. The least wet cross-section of the canals varies from 2.5 to 4.4 times the immersed section of the largest boat. In France there are two distinct types of canals; those of the first type, which are interconnected to a great extent, and embrace nearly all of the canals for large traffic, conform to dimensions established as long ago as 1879, and provide for boats having a carrying capacity of 300 tons; canals of the second type are of much larger dimensions, are adapted only for the larger valleys, and only two have been built up to the present time. It may be said, therefore, that the dimensions suitable for boats carrying 300 tons are adopted in France. The clearance under the loaded boats is a little more than 10 percent of the draft, and the wet cross-section of the canals is about four times the wet cross-sections of the typical 300-ton boat. In Italy, the dimensions now favored are based on the use of boats of 600 tons. In Sweden it is considered impracticable to fix standard dimensions, since local traffic conditions must govern in many cases. For the Trollhättan Canal the dimensions of the cross-section were fixed with reference to a boat drawing 13.12 feet with a clearance under the boat of 10 percent of its draft, and a wet section 4 to 4.5 times the wet section of the largest boat. In Russia the canals appear to be subsidiary to the navigable rivers, and their cross-sections depend on those of the largest boats traversing the rivers, which are taken to be 361 feet long, 52½ feet in breadth and draft of 5.9 feet, and a carrying capacity of 1,700 tons. The canal from the Don to the Volga is to have a bottom width of 140 feet and a wet cross-section area about four times the immersed section of the largest river boats. No standard dimensions applicable throughout the country exist in the United States. The only canals of large traffic are short canals passing around rapids in important lines of communication where the dimensions depend necessarily on the character of the traffic, in which one or two items usually predominate. Of the many small canals formerly operated only one, the Erie Canal, with a traffic of about 2,000,000 tons annually in boats of 250 tons capacity, carries even a moderate traffic, and this is to be replaced by the so-called Barge Canal, with boats of possibly 2,000 tons capacity, the most suitable dimensions of boats being still undetermined; the ratio of wet sections of the canal and boat and the clearance under the boat are therefore yet to be ascertained. If traversed by the largest boats the lock dimensions permit the ratio of wet section of canal to immersed section of boat may be as small as 2.5 to 1.

Among the advantages of large dimensions for canals may be mentioned:

(*a*) Lower cost of transporting goods. In order to make this fully available suitable port facilities should be provided for handling and storing freight, and suitable connections made with other waterways and with railway lines.

(*b*) The aid given by cheaper transportation to the development of trade which otherwise would not exist.

In order to make full use of these advantages it may be necessary to establish low rates of tolls or to make the canal free from tolls. The burden thus imposed on the State may be fully offset by the development of its resources and the increased revenue resulting therefrom.

The topographical conditions may prohibit the adoption of large dimensions, as noted by Mr. Bougougnon in regard to canals similar to the Marseilles-Rhone Canal, a type which he states is "only practicable from an engineering point of view in France in a small number of large valleys with a slight incline and with a large watershed." The dimensions of existing canals and the character of existing port facilities may control in planning new work, as in the case of the Nord Canal in France, where the conclusion appears to be accepted that the dimensions of canal suitable for 300-ton boats are the best. Where a new system is to be developed or old systems modified large dimensions appear to be favored, as, for example, in the adopted project in Italy in which the use of 600-ton barges is provided for; the system now under construction in Germany, providing for boats carrying 600 tons or more, or the New York State Barge Canal, which was designed for navigation by craft carrying 1,000 tons, and the enlargement of the principal Belgian canals to accommodate boats of 1,000 tons and upwards. The local conditions at the Trollhättan Canal have led to the adoption of dimensions suitable for craft carrying 1,350 tons, in Russia the use of canals to connect navigable rivers has resulted in still larger dimensions suitable for large river boats.

The term "principles of operating" has been interpreted in different ways by the several authors; your general reporter will allude, under this head, to ownership and operation, to the levy of tolls, to haulage, whether by monopolies or otherwise, to the development of ports, and to the organization of responsible transportation companies.

It appears to be agreed that waterways for large traffic must be owned and operated by the State or under State control. Tolls are not usually levied in sufficient amount to meet all the costs of constructing and operating the canals. In France they are free except in a few cases, and in the United States are absolutely free in all cases; in Sweden, however, it appears from Col. Hansen's paper that the tolls are expected to cover all costs. Data are not given in regard to the other countries reported on. Mechancial haulage is in use to some extent, both as a State monopoly and under concessions, and is generally believed necessary with heavy traffic. The furnishing of port facilities by the State or by municipalities is regarded as essential; the organization of large transportation companies is advocated in Italy and, it may be added, is regarded as very important in connection with the New York State Barge Canal in order that goods may be way-billed through from point of origin to destination when the waterway is only a link in the chain of communication. Monopolies for towing, operating under State control, are favored in the reports for Belgium and Russia, and a monopoly service has been provided by the municipality on the Teltow Canal in Germany.

In regard to the dimensions of locks, perhaps the most noticeable recent development is more general provision for locking two or more boats together; there is also a tendency to greater lifts, 21.3 feet to 22.3 feet having been adopted in the Nord Canal, one of 40.5 feet in the New York State Barge Canal and one or more in Germany of 65.62 feet.

The use of machinery for operating lock gates and sluices, long in use for locks of large dimensions, is being extended to smaller ones. Side ponds for saving water are in use in many places. Safety devices are alluded to as in use at the St. Mary's Falls Canals; these may be considered as of two classes, the first class consisting of means to avoid carrying away the gates and the release of water from the higher level, the other to means of closing the channel after such an accident. Both of these classes are dealt with by Col. Hodges. Your general reporter may be permitted to refer to what he considers a very

important item of canal equipment serving to reduce risks of accidents to gates, where the traffic is carried on in large ships, viz.: long approach or guide walls, provided with numerous snubbing posts for the purpose of assisting the crew of a ship in checking its speed and bringing it to a stop at a safe distance from the lock.

At the St. Mary's Falls Canals the approach piers above the locks are the side walls of the canals, which are vertical or nearly so, and extend about one mile; below the locks the piers extend 1,500 feet or more, and upon completion of the new canal now under construction this will be increased in the United States canals to more than 2,000 feet.

Since the opening of the first canal to navigation in 1855 the original State locks were operated 34 years, the Weitzel lock has been operated 30 years, the Poe lock has been operated 15 years, the Canadian lock has been operated 16 years; total, 95 years.

During this period the net registered tonnage has amounted to upwards of 600,000,000 tons, with only one accident resulting in the release of water from the summit level. This remarkable result is believed to be due mainly to the facilities afforded by the long approach walls in bringing ships under control.

Your general reporter has endeavored to summarize the opinions expressed by the several authors in the following conclusions:

(1) Standard dimensions applying to canals for heavy traffic, permitting interchange of traffic without transhipment, are desirable in any given country, and for adjacent countries where traffic is international to a great extent.

(2) Assuming suitable ports and facilities for handling freight in all cases as essential for economical transportation, the most suitable dimensions for canals will still depend upon many conditions, and particularly upon the general topography of the country, the nature of the principal items of freight to be transported, and the extent of inter-communication practicable. Such items as grain, ores and coal, loaded quickly with machinery at a single point and unloaded with like devices at another, favor the use of large boats, while smaller ones may be better adapted for general merchandise.

(3) Where extensive and well co-ordinated canal systems already exist it may be inadvisable to change, even if larger dimensions would be better adapted to the traffic.

(4) These various conditions have led to the adoption for canals in Germany and Italy of dimensions suitable for boats carrying about 600 tons and to the retention in France of dimensions suitable for boats carrying about 300 tons, except in some special cases; in other countries still larger dimensions have been adopted in part.

(5) It is not practicable, however, in every country, to establish standard dimensions. The traffic in certain districts may be so different in character and volume from that in other districts as to require special accommodation. Where interchange of traffic is impracticable uniformity in canal dimensions is of less importance.

(6) The question whether canals shall be free from tolls, or what proportion of the general costs of furnishing and maintaining the waterway shall be borne by the State is governed by the policy of the State.

(7) The organization of responsible transportation companies for canals which form links in trade routes, under suitable control by the State, should be encouraged.

(8) Movement of boats by power is desirable in canals with heavy traffic, and is necessary if the boats are large. Where boats are towed in trains by tugs or from the tow-path by electric tractors, the organization of monopolies for haulage, operating under State control, would be advantageous.

(9) Increased traffic capacity of the locks of canal systems can be obtained advantageously by adapting them for locking two or more boats at one time.

(10) The dimensions to be given locks of short canals flanking rapids in rivers will depend on the widely varying character of the traffic, the water supply usually being ample. Where the prevailing traffic is in barges of moderate size, moving in large fleets, as on the Ohio River, it is desirable to have dimensions sufficient to pass a considerable number of boats at one lockage. Each case must be studied by itself and no general rule can be laid down.

(11) For a heavy traffic the equipment of locks for operation by power is desirable. The equipment should be as simple as compatible with effective and safe operation.

(12) In certain cases, as where the level above the lock is connected with a large body of water, or where the unrestricted flow from the upper level would be disastrous to the canal works or to adjacent property, means should be provided for quickly stopping the flow.

3d Question: Intermediate and Terminal Ports—Best Methods for Combining, Facilitating and Harmonizing the Transfer of Freight between the Waterway and the Railway

GENERAL REPORT BY EMORY R. JOHNSON,* Ph. D.

The third question docketed for consideration by the First Section of the Twelfth International Navigation Congress is "Intermediate and Terminal Ports; Best Methods for Combining, Facilitating and Harmonizing the Transfer of Freight Between Waterways and Railways."

The ports to be included under the term "Intermediate and Terminal" are indicated by the following official definition phrased by the executive committee of the Permanent International Association of Navigation Congresses:

"The ports to be considered should be inland ports situated along the exclusively fluvial sections of rivers, along canals for inland navigation and along lakes.

"'Intermediate' ports may be established along these navigable highways if the traffic by water does not all end at the ports, but passes in both directions, as is the case with the port of Nancy.

"'Terminal' ports, on the contrary, are those which control the whole or very much the larger part of the traffic and prevent entirely, or very nearly so, any transportation by water beyond these ports.

"In Belgium, the 'terminal' port of Louvain, at the end of the canal from Louvain to the Rupel, may be mentioned, as may also the port of Leopoldville in the Belgian Congo, at the end of Stanley Pool, where the river navigation of the upper Congo ends.

"The port of Mannheim on the Rhine may be considered, however, as a terminal point, because of the enormous traffic which exists there as compared with the ports of Rheinau and Carlsruhe, which lie further up-stream. Frankfort is in like manner the 'terminal' port of the Main."

This definition of terminal ports excludes such harbors as those of New Orleans and New York, which are the termini of important inland waterways, but which are primarily ocean ports. However, among the papers prepared by the reporters upon the third question of the First Section are three relating to the city of New York. The papers upon New York harbor are of illustrative value, although they deal with ports excluded by the foregoing definition from consideration.

The following contributors have prepared papers that have been referred to the general reporter for review:

No. 22. Herr Stadtbaudirektor Eisenlohr, Strassburg, Germany.

No. 24. M. P. Mallet, Engineer of Arts and Manufactures, Member of the Chamber of Commerce, Paris, France.

* Professor of Transportation and Commerce, University of Pennsylvania, Philadelphia.

No. 27. Mr. M. Tsionglinsky, Engineer of Lines of Communication, St. Petersburg, Russia.
No. 23. Mr. Calvin Tomkins, Commissioner of Docks, New York, N. Y.
No. 25. Mr. Charles W. Staniford, Chief Engineer, Department of Docks and Ferries, New York, N. Y.
No. 26. Mr. S. Willet Hoag, Jr., Deputy Chief Engineer, Department of Docks and Ferries, New York.

From these papers the general reporter reaches the following conclusions:

1. The problem of combining, facilitating and harmonizing the transfer of freight between waterways and railways is partly administrative or governmental and partly technical or mechanical. The methods to be followed in dealing with questions of administration must depend upon whether the railroads are owned and operated by the government or by corporations.

In countries having State railroads the connection and co-ordination of railroads and waterways at ports can be readily accomplished by the co-operation of local and State governments. The necessity for such co-operation is generally recognized, and the requisite distribution between the municipality and the State of financial and administrative burdens is ordinarily made without serious difficulty.

The co-ordination of private railroads with public waterways being generally opposed by the railroad companies, must be, and ought to be, secured by the effective regulation of railroad services by National, State and local governments. The legislative and administrative requirements of the several political authorities should so supplement each other as to make a unified transportation system of the railroads and waterways in each country.

2. Whether terminal and intermediate ports are developed by private interests or by the municipalities, it is essential that each port should be systematically organized for the accommodation of the traffic and the industries to be served. In some instances this has been brought about by public regulation of ports owned and developed solely by private capital; but experience conclusively shows the need of supplementing public regulation of privately-developed terminals with the municipal ownership and operation of wharves, docks, warehouses and other harbor facilities for the general use of the public. The number and variety of wharves and other facilities that should be maintained by the State or municipality at any particular port will depend upon the local requirements of the port. Exclusive private ownership of water terminals is indefensible.

3. The actual legislative and administrative measure to be taken to co-ordinate railroads and waterways, to unify and systematize port facilities and to provide an efficient harbor administration must vary with different countries.

In the United States and countries having similar political organization it is necessary

(*a*) That the Federal Government, which has authority over inter-State commerce and carriers, should require railroad companies engaged in inter-State commerce:

1. To make physical connections with the waterways.
2. To exchange traffic with the waterways.
3. To issue through bills of lading and quote through rates over combined rail and water routes.
4. To secure to shippers the option of dispatching freight by an all-rail or by a rail-and-water line, when a choice of routes is possible.

(*b*) That the several State governments should take similar action concerning intra-State commerce and railroads.

(*c*) That each State should create in connection with the city government of each port a harbor department or board, and should authorize the municipality, acting through this department or board, to take such measures as may be necessary to unify and systematize the physical layout of the water terminal, to construct and operate such public quays, wharves, docks, warehouses and other harbor facilities as may be needed, and, generally, to regulate and develop the port.

4. In countries that do not have a federal government the State and local governments should co-operate (each country according to methods that have been found by experience to be wise and effective) to co-ordinate railroads and waterways to systematize and develop the ports, and to insure their use by the general public without unnecessary restriction or unfair discrimination.

5. The physical layout of intermediate and terminal ports and the mechanical appliances best adapted to the handling of traffic must be determined for each port separately and in accordance with its special requirements. Local, city and State engineers must apply to the solution of local problems, and adapt to local conditions the principles of port organization and operation that have been found effective at other ports and in other countries.

1st Communication: The Application of Reinforced Concrete to Hydraulic Works

GENERAL REPORT BY JOHN STEPHEN SEWELL*

The communications on this subject are as follows:

No. 31. By M. Jacquinot, Chief Engineer of the Ponts et Chaussées, Chaumont (Haute-Marne), France.
No. 32. By R. W. Vawdrey, A.M.I.CE., Portscatho, Parkhill Road, Sidcup, England.
No. 33. By the Hungarian State Water Survey.
No. 34. M. Mederico Perilli, Chief Engineer of the Genio Civile, Ravenna, Italy.
No. 30. By Mr. Richard L. Humphrey, President, National Association of Cement Users, United States of America.
No. 29. By Herr Regierungs and Baurat Schnapp, Berlin, Germany.
No. 35. By M. Alexander Nikolski, Chief Engineer of Lines of Communication, St. Petersburg, Russia.

The objections that have been raised against the use of reinforced concrete for the purpose under discussion relate to the durability of the concrete itself, to its resistance to abrasion, chemical action and freezing in contact with water, and to the durability of the reinforcement under various conditions.

Durability of Concrete

A few years ago difficulty was sometimes experienced in securing a Portland cement that was sound and secure against disintegration due to chemical changes within itself after setting. This difficulty is now easily avoided, and if aggregates are selected of durable and inert materials there can no longer be any doubt that concrete is in itself a thoroughly durable material, quite secure against disintegration due to action originating within the mass itself.

Resistance to Abrasion

Concrete as a rule exhibits more chipping and chafing under impact and abrasion than masonry of the harder stones. But this damage is usually only superficial, and rarely threatens the integrity or continued usefulness of the structure. In many cases it is more resistant than any other form of masonry available within practicable cost limits; the best of masonry is liable to be disfigured under impact and chafing, and there is very little of it in existence subject to these conditions that does not show the wear and tear. In any case, the trouble can be avoided at moderate expense, by means of strips of steel or timbers applied in the proper manner. This objection to concrete is therefore not a valid one, for it can be removed by simple and practicable methods.

Resistance to Chemical Action

Under this head may be included atmospheric agencies, the action of sea water, of sewage and of acidulated water. So far as atmospheric agencies are concerned, there is too much

* Formerly Major, Corps of Engineers, U. S. A., Grant's Quarry, Ala.

concrete which has successfully withstood them to leave any room for discussion. It is merely a question of good materials and workmanship, including proper mixtures to secure a dense and impervious mass.

A great many concrete structures exposed to sea water have suffered from extensive and rapid disintegration. It was at first supposed that this was due to the action of the sea water on some constituent of the cement, probably the free lime. Some experiments and investigations have seemed to indicate that the addition of trass or pozzuolana to the cement would prevent this action by satisfying the free lime. But it also appears probable that, as Mr. Humphrey states, a dense, strong and impervious mixture allowed to harden before exposure in place is in itself sufficiently resistant, whether the preliminary disintegration has been due to freezing when saturated with water or whether it is due entirely to chemical action. The requisite density and strength can best be obtained with a well balanced and rather wet mixture. The conclusion seems justified that exposure to sea water is not necessarily fatal to the use of concrete.

Navigation canals may carry domestic sewage, factory waste and acidulated water from mines, since all of these ingredients are to be found in the waters of streams from which canals are fed. So far as navigation works are concerned, the deleterious ingredients will generally be so diluted that their action will be very slow, and probably the same precautions that suffice in the case of sea water will serve the purpose here also. Should cases arise where the deleterious ingredients exist in greater proportion, it is probable that any kind of masonry would suffer more or less by action upon the cement in the joints, if in no other way; but there are many methods of waterproofing masonry, any one of which ought to protect the concrete from contact with acidulated water or sewage, and therefore from damage. It appears, therefore, that even the existence of these agencies need not be a fatal objection to the use of concrete, for their activities can be prevented at practicable cost; only in extreme cases would such protection be required in navigation works, and even then the protected concrete may easily be the least expensive material available.

Freezing in Contact with Water

Resistance to damage from this cause seems to be merely a question of density and strength. The same thing is true of stone and bricks. That concrete can be made sufficiently impervious and strong is demonstrated by many examples. Here, again, a well balanced wet mixture, protected from washing out of the cement during the hardening process, is all that is required.

Durability of Reinforcement

It is no longer open to serious doubt that steel or iron thoroughly embedded in Portland cement concrete will last indefinitely, as long as the covering remains intact. If it is exposed directly to the air, whether near the sea or not, it will inevitably corrode and ultimately destroy the structure. Careful design and good workmanship are all that are required to properly imbed it, in the first place. The only danger that threatens it thereafter is the danger of cracks, which will destroy the integrity of the concrete and open up a way for atmospheric moisture or water to gain direct access to the reinforcement. Such cracks might be due to shrinkage in setting, to expansion and contraction under changes of temperature, or to deformation under stress. If the concrete is mixed wet, and kept wet while setting, there is small danger of shrinkage cracks. Cracks due to expansion and contraction after setting are brought about probably by a slight slipping of the mass on its bed during expansion, and by the excess of frictional resistance over the tensile strength of the concrete during the subsequent contraction. This trouble can be overcome by proper reinforcement, but it would be well to divide a long wall or other structure into sections, so that each could act as a unit. Cracks due to deformation under stress will occur only when the reinforcement is stressed so that the strain exceeds the limit of extensibility of the concrete. This can be avoided by proper design and workmanship. If working stresses are kept well within the limits allowable for mild steel there is no danger of cracks in the concrete. It appears, therefore, that it is entirely possible to maintain the integrity of the concrete coating and therefore to prevent corrosion of the reinforcement, and there is no valid objection in this score.

Mr. Humphrey refers to the corrosion of reinforcement exposed near the sea. It is also a fact that if the concrete is mixed with sea water, or with sand from the sea beaches, or if it has salt mixed with it, and it is subsequently exposed to dampness, the reinforcement will corrode. It is of importance, therefore, that the ingredients used in mixing concrete for hydraulic works should contain no corrosive material in themselves if the concrete is to be reinforced.

The conclusion seems justified that all of the objections that have been urged against the use of reinforced concrete as a material suitable for use in connection with hydraulic works are either imaginary or can be overcome by practicable methods, and must have arisen at a time when the subject was not so well understood as at present. That this conclusion is justified is abundantly proven by the increasing and successful use of the material in permanent structures everywhere, as indicated by the papers herein reviewed.

The great advantage of reinforced concrete lies in the fact that it is capable of withstanding stresses due to transverse strains, tension and shearing. All the forms that could be executed in steel or timber can be closely imitated in reinforced concrete, which is immune from corrosion and decay. This makes it possible to adopt designs wherein the structure acts by its structural resistance and not by dead weight, and even the material to be retained and held back may be made, by this means, to add to the stability of the work as a whole. Dead weights on foundations are diminished, difficult excavation is often avoided or lessened, and total costs often greatly decreased, as compared with structures formed of masonry in mass; in many cases reinforced concrete affords the only practicable solution of a difficult problem, and in nearly all cases it affords a variety of desirable solutions not practicable in any other material.

The saving in thickness of inverts of locks and dams, of retaining walls of all kinds, the use of caissons filled with dead materials in lieu of solid masonry walls, the use of reinforced concrete piles to anchor a light structure to the dead mass below, and the many other useful devices and applications either described or suggested in the papers on this subject, all open up the possibility of practically limitless applications of reinforced concrete to hydraulic structures so as to attain both greater efficiency and a diminished cost.

A study of the successful applications of reinforced concrete submitted to the Congress by the various reporters appears to justify the adoption of the following conclusions:

Reinforced concrete combines the structural qualties of steel and timber with the durability of good masonry. It is subject to no form of deterioration which cannot be avoided by reasonable precautions. It is free from many of the limitations surrounding the use of masonry in mass; because of the greater latitude it affords in the design and execution of structures, it often yields the best and most economical solution, and in some cases the only practicable solution, of the most difficult problems. When properly designed and executed it is, therefore, among the most valuable, if not the most valuable, material now available for use in connection with hydraulic works of all kinds.

2d Communication: Report on the Works Undertaken and the Measures Adopted or Proposed for the Improvement and Development of Lines of Inland Navigation, as well as for the Protection of the Banks of Navigable Highways

GENERAL REPORT BY HENRY C. NEWCOMER*

Ten reports have been submitted on this subject as follows:

No. 37. Herr Regierungs and Baurat Bergius, in Oderberg (Mark.)

No. 38. Mr. E. J. Marote, Chief Engineer, Director of the Ponts et Chaussées, Brussels, and Mr. Jules Descans, Principal Engineer of the Ponts et Chaussées, Antwerp.

No. 39. Major William D. Connor, Corps of Engineers, United States Army, Member of the American Society of Civil Engineers.

No. 40. Mr. L. Dusuzeau, Chief Engineer of the Ponts et Chaussées, Professor at the National School of the Ponts et Chaussées, Compiegne (Oise).

No. 41. Mr. J. A. Saner, M. I. C. E., Chief Engineer of the Weaver Navigation, Northwich.

No. 42. Mr. Antonio Castiglione, President, and Mr. Mario Beretta, Secretary of the Committee for Inland Navigation, Milan.

No. 43. Mr. A. R. Van Loon, Engineer of the Waterstaat, Bois-le-Duc.

No. 44. Mr. E. A. Wodarski, Engineer of Lines of Communication, St. Petersburg.

No. 44*bis*. Mr. Emile de Hoerschelmann, Councillor of State, Member of the Council of Engineers at the Ministry of Lines of Communication, Tsarskoie-Selo (near St. Petersburg).

No. 45. Captain G. Malm, of the Royal Corps of Bridges and Roads, Chief Engineer of Works of Construction of the Royal Administration of Hydraulic Motive Powers of Sweden, Stockholm.

Two of the reports, Nos. 39 and 44, cover in a comprehensive way the general waterway situation, while the rest have been devoted mainly to certain features, to recent improvements in design, plans for new work, or measures proposed for the further development or improvement of navigation facilities.

R. Bergius gives some recent improvements in canal construction in Germany, including a flight of four locks and a safety gate on the Berlin-Stettin waterway, a new arrangement of inverted siphon culverts under the Datteln-Hamm Canal, and several forms of canal bank protection.

E. J. Marote and J. Descans describe the principal waterways of Belgium and the further improvements that are contemplated. In each case, however, the main attention is devoted to the forms of bank protection in use.

The authors conclude that

"1. In the canals where the navigation traffic is not intense, where the draft of the boats is low and where the circulation of screw-propelled boats is nil, the slopes are generally protected by plantation of osiers, or reeds or alders on the berms placed several centimeters below the water level. As the traffic develops the necessity of a more efficacious protection makes itself felt, and recourse is had to simple or double puddling

"2. When steam or motor traction is used, the erosions, due to current or wash which the boats cause, soon occur in mobile soils. This is generally remedied by the construction about the center of the water level of a skirting supported on piles and surmounted either by turfing or by protection in hard materials either in masonry work or not. When the local circumstances allow of the lowering of the water during more or less long periods, stonework in masonry or dry is preferred, founded on a berm generally one meter below water and sometimes supported by a framework of piles and skirting.

"3. When the navigation of screw-propelled boats is great and when the lowering of the water level is not admissible the consolidation of the banks is obtained either by the 'Villa' system or by the driving down of a row of piles and of a sheet-piling frontage surmounted by a covering of hard material above the water level.

"4. At the Congress of Vienna the relation between the immersed cross-section of a boat and the wetted cross-section of a canal has been fixed at one-fourth, in the supposition that the speeds of the boats would not be greater than 6 kilometers per hour.

"5. The only means of protecting effectually the concave banks seems to consist in the covering of them with natural or artificial stones in masonry or dry, supported on a simple berm either on stone pitching or on a framework consisting of piles with skirting of sheet piling.

"6. In the interest of navigation and with a view to suppress stoppages to navigation, or at least to reduce their duration, the method of bank protection should be designed in such a manner as to permit their maintenance without lowering the water level either under cover of sheeting or easily removable and fixed cofferdam."

W. D. Connor gives a general account of the inland waterways of the United States and of the types of works used in their improvement.

L. Dusuzeau's is devoted to a brief discussion of the measures adopted or proposed in France for the suppression of general and periodical stoppages of traffic to make repairs, and for the methodical organization of waterway transportation. The measures proposed are as follows:

A. "General stoppages must be abolished—at any rate on much frequented navigable waterways.

"Such waterways should be made fit to undergo this new regime, for which purpose the following measures should be taken:

"1. Put the under-water masonry into perfect order.

"2. Choose a type of slope protection such as can be installed and maintained by means of movable dams of simple construction and at low cost.

3. Adopt a design of rigid iron lock gates without any woodwork about them, as wood continually requires repairs; prefer a means of closing sluices and gates which does not involve the use of delicate parts under water; such as the gate with a vertical heel post, and especially the balanced lifting gate.

"4. For weirs in canalized rivers, give up those with needles which lie down on the floor and which floods and floating ice damage every year, and have recourse to great balanced sluices generally worked by steam or electricity, which can also, if the need arise, be worked by hand.

"5. Make provision in the inverts and the lock heads for appliances to which cofferdams can be easily fitted so as to get at some part or the whole of these works without lowering the water in the reaches.

B. "1. The installation on navigable waterways having an average traffic of over twenty barges a day, of haulage services monopolized by the State itself or under contract from it, with fixed charges, in connection with, and having similar rates to, the various systems in each State and in the neighboring ones.

"2. The appointment of special establishments which would form a link between the shippers, the consignees and the boatmen.

"3. Unification, in neighboring States, of the general principles governing police conservancy regulations on navigable waterways and the laws applicable to demurrage charges on inland navigation."

The report by Antonio Castiglione and Mario Beretta is devoted to an explanation of the Bertolini law concerning inland waterways in Italy, after stating the circumstances leading up to its enactment. It is the outcome of an agitation for improved navigation that has been in progress for about ten years. The State has had control of navigable waterways, but they were allowed to deteriorate, and many proposals were made calling for the restoration of old channels and the provision of new ones. The principles governing the apportionment of necessary expenditures, as well as the determination of a programme of procedure, were finally settled, after much discussion, by the passage of the Bertolini law in January, 1910.

A. E. Wodarski attaches great value to dredging as a means of improvement for Russian rivers; he also gives instances of

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successful regulation, and he considers this method essential on some streams and canalization on others, especially in cases where considerable increase in depth is sought.

3d Communication: Utilization of the Navigation of Large but Shallow Rivers—Vessels and Motors

GENERAL REPORT BY LANSING H. BEACH*

Four papers have been presented on this subject as follows:

47. A comparison of the relative economies of a side wheel and a propeller-in-tunnel towboat, by Herr Director R. Blumcke of Mannheim.
48. Reasons for the decadence of traffic on the Mississippi River, by C. McD. Townsend, Colonel, Corps of Engineers, U. S. Army.
49. The tunnel towboat as used on the Trent, by F. Rayner, General Manager of the Trent Navigation Co., Nottingham.
51. Statement concerning motor boats on Russian rivers, by H. Merczyng, Professor at the Institute of Engineers of Lines of Communication, St. Petersburg.

In the report by Herr R. Blümke it is stated that owing to the building facilities afforded by the Dutch ship-mortgage banks, the Rhine has suffered from an over-supply of barges, and it has become the earnest endeavor of German shipbuilders to provide a light draft towboat which shall be powerful and still relatively cheap. As the result of their studies in this direction the Schiffs-Maschinenbau A. G., of Mannheim, produced the twin-screw tunnel steamer *Gebr. Page X*, this boat being a development from numerous smaller tunnel steamers built by the same company. In order to finally determine the relative efficiency of the tunnel and side-wheel types of towboats, comparative runs were made upon the upper Rhine with the *Gebr. Page X* and the *Bavaria*, a side-wheel boat of about the same power. The conclusion is drawn from these trials that the tunnel boat is at least the economical equal of the side-wheel steamer, and the further advantages of low first cost, minimum width for use in narrow rivers and canals and reduced cost of maintenance are cited. The data includes the relative costs of producing 1 pound of towrope pull at 7.8 miles per hour with the two types, and also the cost per ton-mile of freight carried by these two types of boats. From these results the foregoing conclusion is drawn.

The most important conclusions reached in Mr. Townsend's report are:

1. That the problem of the "Utilization of the Navigation of Large but Shallow Rivers" differs in different countries and is a function of the extent and efficiency of their railroad systems.
2. To obtain supremacy for river navigation it is necessary to utilize the towboat and barge method rather than the freight-carrying steamboat.
3. With this method and a 9-foot channel as great economies of transportation may be obtained as on the Great Lakes, and with a 6-foot channel greater than at present obtain on railroads if equal terminal facilities are provided.
4. A revolution in the means of propulsion by the introduction of electricity or liquid fuel will not revive river commerce where the railroad can utilize the invention as cheaply as the boat, although the motor boat for subsidiary lines will reduce the cost per ton mile owing to the small crew required.
5. The utilization of the navigation of large but shallow rivers is a factor of the density of traffic and of population.

The tunnel type of towboat, as used on the Trent, is described by F. Rayner, and the author reaches the conclusion that the hinged flap in a tunnel will yield an increase of speed of 1 knot beyond that obtained by a boat of the same dimensions and power when equipped with the usual type of tunnel.

Conditions on Russian rivers are reviewed by Prof. H. Merczyng, and the statement is made that Russian designers have been forced to the saving of weight by the adoption of the internal-combustion engine. The construction of boats in detachable sections is advocated in order to provide means of reducing draft by the addition of one or more sections.

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IId Section: Ocean Navigation

1st Question: Means for Docking and Repairing Vessels

GENERAL REPORT BY MORDECAI T. ENDICOTT*

According to the reports upon the above question there are three things of especial importance dwelt upon therein, viz.: First, the methods and details of construction of docks for taking up seagoing vessels, which contain many actual experiences with valuable lessons for the information and guidance of those who construct and use them. Second, the great value to a port and its shipping of ample establishments for docking and repairing vessels, and the failure to keep pace, in this respect, with the constantly-increasing size of vessels, both for the merchant and naval marines. These papers contain a forecast of vessels of an ultimate length of 1,300 feet and breadth of 135 feet, and it does not seem unreasonable to look forward to these dimensions, and to provide docking facilities which shall be able to receive and repair them. Third, the types of dock suited to the docking and repairing of vessels. This last is a question which has engaged the earnest attention of previous Congresses. In the present reports it is, without exception, treated more or less fully, and opinions differ considerably. Two of the writers express opinions in favor of the floating dock, under practically all circumstances; four regard the graving dock as superior for nearly all docking work, and three express no special preference for either. Substantially all the writers refer to local conditions as affecting the practicability or advisability of establishing one or the other type, and some have left the subject with the remark that the type to be used must be determined by local conditions, without giving an opinion as to which type, other things being equal, is to be preferred.

There can be no doubt that the decision as to the type of dock to be used in any locality must be made after a careful consideration of the conditions existing there; there may be some feature in the situation which would preclude the establishment or use of one or the other type; there may be conditions affecting the cost to so great extent as to settle the matter upon this basis alone, but there is in the minds of most engineers and naval experts a definite opinion as to the value and desirability of the two types where practicable to establish them, and the writer is of the opinion that this is the decision, if any, to which the Congress should give expression. Which type, when practicable to be installed, best meets the demands of commerce for the safe and economical docking and repairs of seagoing vessels? It is believed that the Congress could reach a decision upon this point, and it is such a decision as would be of value to the world, and for which, perhaps, it has some reason to look.

The preponderance of opinion, in the reports reviewed, is in favor of the graving dock. A study of all these reports, both pro and con, serves to confirm the opinion of the general reporter, formed after an observation and experience extending over a long term of years, that graving docks supply in the greatest degree the conditions of safety, convenience and economy for the docking and repairs of seagoing vessels.

2d Question: Dimensions to be Given to Maritime Canals—Technical Point of View—Probable Dimensions of the Sea-Going Vessels of the Future

GENERAL REPORT BY C. E. GRUNSKY,† Dr. Eng.

There have been six papers submitted to the general reporter on the above question. These are as follows:

No. 63. By G. de Thierry, Baurat, Professor an der Königl. Technischen Hochschule Charlottenburg, Mitglied der Internationalen Technischen Commission des Suez Kanals, Berlin-Halensee, Germany.
No. 64. By H. Vander Vin, Ingénieur en chef Directeur des Ponts et Chaussées, Antwerp, Belgium.

* Rear Admiral, U. S. N., Retired, Washington, D. C.
† San Francisco, Cal.

No. 65. By Dr. S. E. L. Corthell, Civil Engineer, New York, United States.
No. 67. By J. Foster King, Chief Surveyor to the British Corporation for the Registry of Shipping, Glasgow, Great Britain.
No. 68. C. Leemans, Civil Engineer, Amsterdam, Holland.
No. 69. By E. I. Zamjatin, Naval Engineer, St. Petersburg, Russia.

This question is understood by the general reporter to relate specifically to the minimum dimensions of the canals and to the dimensions of the large seagoing vessels. The interrelation of the size of the largest seagoing vessels and of the required dimensions of the canals is recognized in the question.

If it be admitted that the dimensions of the seagoing vessels are to be determined solely by the needs of trade and commerce, by economy of operation, and by the demands of passengers for speed, comfort and luxuries, without regard to harbor facilities and without regard to the possible usefulness of the vessels to their governments in case of war, then it becomes comparatively easy to predict future growth. As Dr. Corthell contends, the law would really be inexorable,and no one could foresee a limit to the size of the largest vessel.

But, and perhaps fortunately, there are other considerations to be taken into account, notably the general usefulness of large vessels, which, according to their size and particularly their draft, may be materially restricted by the dimensions of maritime canals and the depth of the approaches to the principal harbors of the world. To this point particular attention is asked, and the Twelfth International Navigation Congress may well consider whether or not it is desirable to point out other means of restricting the rate of increase in the size of vessels than only by the demands of the shipowners and the ability of the shipbuilders to comply with these demands.

It appears from all of the papers which have been submitted that there is no check yet apparent to the rate at which the dimensions of the largest seagoing vessels are increasing. The vessel of over 50,000 tons is being built, and those who should know expect the vessel of 70,000 tons or more to put in her appearance soon.

Would this be possible without government aid? Some of the transatlantic steamship companies are so heavily subsidized that their ships are practically in government ownership. On the Pacific, too, the economic success of transportation in large vessels is made possible by subsidies in one form or another. Our own country, which does not subsidize, is out of the running. It has no merchant marine to speak of. In other words, the operation of large steamers without subsidy is not profitable, at any rate not in competition with subsidized vessels.

And yet, if commerce between nations had been developed without government aid, and if the commerce on the high seas nad been and were carried on only by vessels of moderate size, there would have been a suitable adjustment to such conditions, and there would be little if any less volume of business between nations than is found to-day.

Perhaps, upon careful analysis, it may, even under established conditions, be found preferable to operate ten steamers of 10,000 tons each, rather than only two of 50,000 tons. From the standpoint of the government of any maritime country it would certainly be more desirable to have at its disposal when needed ten ships of 10,000 tons than two of 50,000 tons.

Having given consideration to the views of the experts as presented in these papers, the general reporter adds that no evidence has been found by him and none is presented in the papers which would indicate that for the present any other consideration than the demands of commerce and the willingness of the traveling public to pay for room, comfort and luxuries, and the ability of the shipbuilders to build the ships will set a limit to the size of the ocean liner. In other words, if the deepening of the harbors and of harbor approaches is continued without restriction the size of the largest ocean liners will, under otherwise permanent conditions, continue to increase.

Without any restrictions upon the size of vessels they will be built constantly larger as demanded by economy of operation and by the needs of commerce, and only those ports can hope to be favored with the visits of the largest vessels which find it worth while to afford suitable harbor facilities.

The growth of vessels, therefore, exerts a strong influence upon the concentration of the export and import business at certain points, such as New York harbor, where nature has made possible the construction of the facilities demanded by the shipowner who wants to operate the largest boats that can with safety and without delay be taken into and out of the best harbors on the two sides of the Atlantic.

It follows from this that it is to the interest of the port which is less favored by natural conditions that some artificial limit be set to the size of the ocean carriers, particularly in the matter of draft, in order that harbor improvements may be planned with reasonable certainty that they will be adequate.

There should be an international agreement entered into that some depth of water at low tide is the standard to which the important harbors of the world should be improved, and there should be no government aid in the form of subsidy or otherwise to vessels whose dimensions are such as to make the entrance into a harbor of standard depth impossible.

It would be unwise, for example, for the United States to construct or to encourage by subvention or otherwise the construction of vessels too large to pass through the locks of the Panama Canal.

The usefulness to the government in time of war of a vessel depends upon its adaptability to the momentary requirements. It should be large enough, and yet not of such colossal dimensions that it cannot make port at some unforeseen new destination.

By the construction of the Panama Canal, a stupendous undertaking, the United States has practically set an upper limit for the dimensions of vessels whose construction can be encouraged by the Government. The canal and the lock system on the canal have cost too much to be readily modified. For the time being the usable lock length on this canal of 1,000 feet, the breadth of 110 feet and the depth of 41.5 feet on the sills of the lock gates, equal to 40 feet in salt water, or to 12.2 meters, has fixed the maximum dimensions both of war vessels and other vessels that are likely to be constructed by the United States or by American owners under the stimulus of Government aid.

But if the standard maximum dimensions for the largest desirable seagoing vessels be thus set by the United States, or by an international agreement participated in by the important maritime nations, this will not set a limit to the further improvement of shipping. There is room for improvement even when the limit of size has been reached. The internal combustion engine, for example, is full of promise, and may, as forecasted by Mr. Zamjatin, be of material aid in increasing cargo capacity. The gain in cargo capacity resulting in the use of internal-combustion engines would, moreover, be of particular value, because it is obtained without an increase in displacement. So, too, in the matter of speed there need be no limit set, unless for subsidized vessels it be a lower limit. If the reduction of weight of machinery and of fuel in the motor boat compared with the steamboat even approaches the figures given by Mr. Zamjatin, there should be ample opportunity for securing high speed without being compelled to give the vessels abnormal dimensions.

It remains to be stated that the largest vessels on such special routes as the one between New York and European ports stand apart in a class by themselves, and their dimensions need not be taken into account in forecasting the dimensions of the vessels for whose use the great maritime canals such as the Suez Canal and the Panama Canal and other canals of the first rank are constructed.

The following conclusions appear to be justified and are recommended for adoption by the Congress:

1. It is desirable that a limit be set to the draft of seagoing vessels.

2. Government aid should not be extended to the building or operation of seagoing vessels whose draft exceed 32.2 feet.

3. There should be an international agreement fixing the maximum dimensions of seagoing vessels built or operated under Government subvention, and there are tentatively suggested the following:

Length over all, 900 feet.

Breadth, 105 feet.

Draft, 32.2 feet.

4. Any maritime canal which has locks with a usable length of 1,000 feet, a width of 110 feet, and a depth of water on the sill of 35 feet will fulfill every reasonable requirement of commerce.

5. In a maritime canal a wet section five times as large as the immersed portion of the largest ship which is to use the canal is desirable, as also a depth of 1 meter under the keel; but these values are functions of the speed at which the canal is to be navigated, and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

3d Question: Mechanical Equipment of Ports

GENERAL REPORT BY JOHN A. BENSEL*

Seven reports on the Mechanical Equipment of Ports have been submitted. Five of the reporters have confined themselves to the mechanical equipment for the loading and unloading of vessels. Mr. Barling has gone briefly into the mechanical equipment for the operation of drydocks, wet docks and tidal basins, and Messrs. Wouter, Cool and de Kanter have briefly described floating docks for the repair of vessels and a steam ferry for the transportation of railroad cars.

The mechanical equipment for loading and unloading vessels may be divided into that used for general cargo or package freight and that for bulk materials, such as grain, coal and ore.

Machinery for Handling General Cargo

In Europe ships are usually moored to quays or dock walls having solid foundations on which are located sheds or warehouses with railroad tracks on both sides. Quay cranes have been in use for nearly four centuries operated by man-power and by steam, hydraulic and electric motors. There has been an enormous increase in such cranes during the past ten years. Many are owned by municipalities, which accounts for their installations in places where they may not directly pay a direct profit sufficient to cover the cost of interest and depreciation and operation. Many of these cranes do not work more than from 1,000 to 1,500 hours in a year.

Hydraulic cranes are still used in old installations, and in England are preferred to electric cranes, but in most places new installations are electrically operated wherever current can be obtained from a central power station.

The general type is that of a traveling gantry spanning one or more railroad tracks, carrying on top of it a revolving jib crane. One leg of the gantry runs on a rail on the edge of the quay and the other on another rail on the ground or on the roof of the freight shed. These are called portal or semi-portal cranes. Most of them are moved along the tracks by hand power, but some of them are traversed by power. Some have fixed jibs and some have movable jibs, which decrease the distance through which the load is transported, and which obviate the necessity of removing shrouds, stays and other rigging from the vessels. In some places the entire crane is supported on the roof of the warehouse. The capacity of these cranes is from 30 cwt. to 3 tons.

Various types of cranes with grabs, buckets, wall cranes, lowering cranes where no load is to be hoisted and the crane hook is raised by a counterweight, wall cranes for loading cars from the warehouse and warehouse elevators and hoists, are also in use.

"Transporter" cranes of the traveling gantry type, with a hinged arm extending over the vessl's hatch while the load is transported in a straight line at right angles to the vessel, suspended from an overhead traveler, are also in use and are more efficient under certain conditions.

Floating cranes, usually steam operated, are much used, and they vary in capacity from 1½ to 100 tons or more.

One or more heavy-duty cranes up to 150 tons capacity are usually provided in each important port.

In the United States and Canada the mechanical equipment for handling general cargo has not reached the development that it has in Europe. Cranes or other devices provided by the municipalities are almost unheard of, and in most places the savings by machinery over the customary methods do not pay for the interest, maintenance and operating cost. Many of the wooden pile piers at which ships unload are not strong enough to carry heavy cranes. General cargo is usually handled by the ship's winches. The quay cranes in use in Europe are almost unknown. In this connection it should be noted that in Europe the "wagons" or freight cars are usually of the type known in America as "gondolas," without any roof, the merchandise being protected from the weather by covers of waterproof canvas. In America general merchandise is usually carried in "vans" or box-cars, which cannot be loaded directly by means of a crane. Other reasons why the cranes used so largely in Europe are not used in America are clearly set forth in Mr. Hodgdon's paper.

Hand trucks of a peculiar pattern are largely used to transport the freight from the point of unloading to the cars or storage space. In many places mechanical aids have been devised to assist in handling these trucks, such as elevating ramps and moving platforms.

Electric telpherage has been installed in some places. This apparatus consists of an electrically-driven car carrying a hoisting winch and the operator, suspended from wheels which run on a single overhead track. The goods are placed in skips, crates or slings for transportation from the unloading point to the point of deposit. The tracks are arranged in circuits so that the carriages do not go and return by the same route.

There are some installations of the "transporter-crane" type for handling freight from cars to barges and lighters.

A feature of freight handling in New York is the car float, by means of which eight to twenty-four railroad cars are brought alongside a wharf or vessel from the railroad terminal.

Floating cranes and derrick lighters having capacities from 20 to 100 tons are in use as in Europe, and there are some stationary cranes having capacities up to 150 tons.

Machinery for Handling Grain

Grain is handled by special installations, and machinery and the general principles do not vary very much in various parts of the world. Floating elevators of the bucket and pneumatic types are used for transferring grain from one vessel to another, or from the vessel to the "silos," storage bins or other places of deposit. Bucket elevator and conveyor or "transporter" belts are in general use for moving the material about on land. The operation is much simplified in America by the system by which identical ownership is dispensed with. All grain is graded as soon as received at the storage point, and all grain of the same quality is stored in the same bins, certificates of deposit showing quantity and quality being issued to the owner.

Machinery for Handling Coal

Coal-handling machinery may be divided into two classes—that for ships' bunker coal and that for cargo coal.

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In many ports in America as well as in Europe there are barges of 600 or 700 tons capacity fitted with bins having "hopper bottoms," from which the coal falls by gravity onto a conveyor, which carries it to a tower elevator and empties it by means of a chute directly into the ship's bunkers.

The machinery for handling cargo coal has its largest development in America. Car tipples, which dump a car of 100,000 pounds capacity at one time, are not infrequent. Similar machines are in use in Europe but are of less capacity. Traveling or "transporter" cranes are used in many places.

Machinery for Handling Ore and Minerals

The handling of ore and minerals has reached an extreme development on the Great Lakes of America, where by means of specially designed ships enormous elevated storage bins and huge grabs vessels carrying 10,000 tons can be unloaded and loaded within a few hours.

Special Machinery for Various Materials

Special installations have been described as follows: Fish, bananas, cotton, garden produce, passengers' luggage and phosphates.

1st Communication: High-Powered Dredgers and Means of Removing Rock Under Water

General Report by W. L. Saunders*

The reports upon this subject, eight in number, are from Mr. Michael Koch, of the Royal Hungarian Navigation Board in Orsova, Hungary; Mr. Vidal, Ingenieur en Chef des Ponts et Chaussées, Bordeaux, France; Mr. Ramon Hernandez, Ingenieur du Corps Espagnol des Routes, Canaux et Ports, Oviedo, Spain; Mr. N. K. Sundblad, engineer, chief assistant to the works of the Trollhättan Canal, Trollhättan, Sweden; Mr. Viovanni Fossataro, Ingegnere del Genio Civile, Venezia; Mr. R. Blumcke, director of the Shipbuilding & Machine Works Company, Ltd., Mannheim, Germany; Mr. Sidney B. Williamson, chief engineer Pacific Division, Isthmian Canal, Corozal, Canal Zone, Isthmus of Panama, and Messrs. A. de Kanter and H. C. Wesseling, engineers on the Works of Rotterdam, Holland.

These papers describe exhaustively and thoroughly the subject of high-powered dredgers and the means of removing rock under water; and the wide experience and ability of the authors, which has attained for them their pre-eminence amongst engineers, makes each report authoritative on the subject with which it deals.

During the last few years the design of dredging machines has undergone a marked change. This change has been towards increasing the output of the dredgers by the construction of dredgers of greater power and larger size. The tendency of these improvements is well illustrated in that great suction dredger built for use on the Mersey; this dredger (aptly named the *Leviathan*) has a rated capacity to excavate the enormous quantity of 10,000 cubic yards in 50 minutes. Other examples of radical improvement in design and efficiency are those dredgers built on the Frühling system, whereby the proportion of solids excavated has been so much increased in hydraulic dredgers. The elevator dredger recently built in Scotland for the Panama Canal, with buckets of 2 cubic yards capacity each, and the large dipper dredgers in America with buckets up to 15 cubic yards in capacity, are other examples of this trend towards increased size and capacity.

It is found from the standpoint of an investment, where the amount of material to be excavated justifies it, that the lessened cost per cubic yard excavated, due to the decrease in the cost of management, labor, fuel and maintenance, more than compensates for the great outlay necessary to construct these larger machines. The increasing use of cast steel has been a great factor in the improvement of dredgers. This is especially evident where manganese steel has replaced the softer steels in bucket mouths, pin connections and other parts exposed to great wear.

In the United States, until very recently, the elevator dredger has not been regarded with favor. It was generally regarded by our engineers as a machine adapted to soft material, and more costly to build and maintain than the suction, dipper or grab dredger.

The performance of elevator dredgers on the Panama Canal, which are rebuilt machines of the French régime, has gone far to establish, through their economy of output, their many advantages, as is evidenced by the purchase of a large machine of this type in Scotland for use on the canal.

In Canada the elevator type had been in favor and use even before the dipper dredger had been developed. It is now being recognized that in hard material, such as hard-pan and indurated clay, where the formation is not hard enough to justify the use of explosives under water, the elevator type is more efficient than the dipper type. This was demonstrated on the St. Lawrence River in excavating a water-power canal through indurated clay. In this instance dipper dredgers of the most powerful design failed, and were replaced by an elevator dredger which completed the excavation in a satisfactory manner.

The dipper dredger, on the other hand, has its advantages over the elevator type under many conditions, and under certain circumstances (as in the construction of canals) is complementary to it.

General Conclusions

The type or designs of dredger that may be employed is governed by the surrounding conditions in which it works.

Generally considered, where the scene of operation is open water and excavating light material, such as mud or sand, suction dredgers with a drag suction, or elevator dredgers, may be employed to the greatest advantage.

Where the situation is confined, as between and around docks and in narrow channels, the grab or clam-shell and the dipper dredger are better adapted for the purpose.

In classifying the types in accordance with their effectiveness in the different classes of material, it would appear that the Frühling system has developed the greatest efficiency in excavating mud and fine sand. This efficiency is due to the design and action of the suction head, which, it is stated, will under certain favorable conditions excavate a semi-fluid mass of a consistency from 80 to 90 percent solid. It is stated that the average cost, all charges included, over a full season's work, has reached the low point of nine-tenths of 1 cent per cubic yard.

In the clays, suction dredgers fitted with revolving cutter heads at the mouth of the suction pipe have proven most effective.

In hard clays the elevator and dipper dredgers give the best results.

The very hard indurated clays, shales, soft rock formations and hard-pans, are excavated most economically by elevator dredgers. This refers to dredging without previous blasting.

Rock that has been broken is most economically dredged by the elevator type or the dipper type of dredger. Where the rock is broken by breakers of the Lobnitz type, and where the depth of each breaking is limited to 2 or 3 feet, the elevator dredger, owing to its ability to dredge closer to a given grade, is more effective. Where rock is drilled and blasted, the rock being broken in large pieces and the depth of the cut or broken masses of rock more than 3 feet, the dipper dredger will demonstrate superior economy. This does not apply to excavations in depths of 35 feet or more, as the dipper

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dredgers, owing to their mechanical design, lose their effectiveness beyond certain depths.

From a great amount of data available it would appear that drilling and blasting by the American method is the most rapid and economical means of preparing the harder rocks for dredging where the depth of rock to be removed is greater than 2 feet in depth. When the rock to be removed is less than 2 feet in depth, the Lobnitz type of crusher attains greater economy as a means of breaking rock. This depth of 2 feet may be increased in thinly stratified rock or in rock that shatters easily.

2d Communication: Report on the Most Recent Works Constructed at the More Important Seaports and Especially on those Relating to Breakwaters—Applications of Reinforced Concrete—Means for Insuring its Preservation

GENERAL REPORT BY EDWARD BURR *

Upon the second communication, second section, Ocean Navigation, the reports before the Congress are ten in number, viz.:

1. The General Government of Algeria.
2. H. Mönch, Geheimer Oberbaurat und Vortragender Rat im Reichs-Marine-Amt, Berlin.
3. C. Bech, Engineer in the Royal Danish Waterworks Department, Chief Engineer to the Harbour Trust of Helsingör (Elsinore). N. C. Monberg, Civil Engineer and Undertaker, Copenhagen. H. C. V. Möller, Chief Engineer to the Harbour Trust of Copenhagen.
4. J. F. Hasskarl, Director, Department of Wharves, Docks and Ferries, Philadelphia, Pa.
5. J. Voisin, Ingénieur en Chef des Ponts et Chaussées, Boulogne-sur-Mer.
6. A. E. Carey, Member of the Institution of Civil Engineers, and Fellow of the Royal Geographical, Chemical and Geological Societies, London.
7. I. Inglese, Inspector-General of the Corps of Civil Engineers, Genoa. L. Luiggi, Inspector-General of the Corps of Civil Engineers and Professor of Hydraulic and Maritime Construction at the Polytechnic School, Rome.
8. V. de Blocq van Kuffeler, Engineer of the Waterstaat, Hoorn, Netherlands.
9. Albert Lundberg and Wollmar Fellenius, Sweden.
10. A. Hermann, Ingenieur en Chef des Ponts et Chaussées Directeur Général de la Compagnie des Ports de Tunis, Sousse et Sfax.

The subject matter of the communication naturally has led to reports dealing with harbor works that involve (*a*) general types of construction; (*b*) the application of reinforced concrete to such works, and (*c*) the preservation of reinforced concrete in harbor works, with references also to the durability of plain or non-reinforced concrete.

Breakwaters, Jetties and Sea Walls

The fourth question before the Tenth Congress at Milan in 1905 had for its subject "Conditions Affecting the Force of Waves and the Construction of Breakwaters to Resist Them," and eight reports thereon were before the Congress by engineers representing five nations. Since the subject has been discussed by the Congress at such a relatively recent date, the reports now submitted may practically be considered as in continuation of the earlier reports, excepting as they are modified by the application of reinforced concrete methods or other recent developments in construction. Your general reporter is in full accord with the action of the Milan Congress, as well as with the conclusions of earlier Congresses, that the selection of a type or system of construction depends upon a large number of very variable local conditions. The conclusions of the general reporter to the Milan Congress in respect to conditions affecting the force of waves will provide the safest guide to the engineer in his studies for new works, and they were adopted by that Congress. In so far as those conclusions relate to the design of new works, they read that

"In projects for new works in the open sea, the engineer will find most valuable information by examining existing works, by taking into comparative consideration the regimen of the swell outside, the shape of the shores and the lay of the bed of the sea in the approaches to the port, and every other condition which may give him useful elements on which to work," and the present writer recommends adhesion to these views without attempt to modify them even though in some details they might be extended and elaborated.

The Application of Reinforced Concrete to Harbor Works

Of the various applications of reinforced concrete to harbor works, the type that is most distinctively peculiar to such works, in contradistinction to structures built for other purposes, are the reinforced concrete caissons or cellular blocks now utilized to permit of massive or monolithic construction of breakwater walls and of retaining or other walls for interior harbor works and to avoid the placing of green concrete under water. These methods have largely superseded for such works the steel caissons with manifest advantages, and form in effect permanent sectional cofferdams within which operations can proceed in the dry, with more economical mixtures than are permissible in subaqueous concrete or in block work, and even in some instances with a filling only of sand, stone or other ballast without mortar. For wharves and landing piers and similar purposes the application of reinforced concrete continues to progress rapidly, as it is also for bank protection.

If any conclusion can be formally stated upon this subject the general reporter would recommend as follows:

Experience to the present time demonstrates that the engineer has in reinforced concrete a valuable device suitable for application to a wide and increasing variety of structures, and it merely rests with him to develop it further and apply it properly. Many heretofore undeveloped or obscure points in theory and in practice have been cleared up, but others remain for further study, and in this direction, as well as in the improvement of the details of design, lie the most important fields for future investigation.

The Preservation of Reinforced Concrete in Harbor Works

There still remains much doubt in the minds of engineers as to the reliability and permanence of reinforced concrete immersed in sea water or exposed to its effects. This doubt arises primarily from uncertainty regarding the effect of sea water upon the Portland cement or other binder employed in the mortar of the concrete, since if the concrete is properly proportioned and put into place, and if it continues sound and intact, little remains to be done for the preservation of the steel. The problem, therefore, in its essential features, resolves itself into the employment of a cement or mortar unaffected by sea water and its utilization in such a manner as will prevent access of sea water to the interior of the concrete and to the steel, with such additional precautions as experience may show to be efficacious. This short statement of the case is simple in terms, but its solution rests upon the determination of the most suitable cement and mortar to produce permanent results when used in concrete placed in sea water, which question has for years been before engineers for solution, and now has increased importance through the advent of reinforced concrete. In one respect, however, the problem is less difficult than would otherwise be the case, since it is only in rare instances that reinforced concrete cannot be seasoned before being exposed to sea water, and methods for its preservation can be employed under these circumstances that are not available for subaqueous work, with its attendant difficulties and possible defects.

The writer is of the opinion that in good, sound concrete, plain or reinforced, the engineer has a most valuable device adaptable to meet many conditions in maritime works; that if designed with good judgment and applied with discretion it

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will permit of the execution of works that might otherwise be financially or physically impracticable and will ordinarily permit of economy in permanent works; that it is reasonably permanent in sea water if applied with all the precautions that experience to the present time has suggested, and that further experience may provide additional means for increasing its reliability; but that no precaution should be omitted in its application. He would not, however, be considered as advocating the use of concrete under any and all conditions, and recognizes that in some situations other materials, alone or combined with concrete, give better or more economical or more permanent results.

It is evident from the reports before the Congress, and more especially from the current literature upon this subject, that experience with reinforced concrete in sea water has not, to the present time, covered a period sufficiently long to permit of laying down conclusions in detail as to the best methods to be followed for its preservation. With longer experience such conclusions might be so formulated as to meet the approval of the Congress, and some of them might be put forward at this time. It would seem, however, to be wise merely to refer to the experience heretofore gained in the matter of such details, as contained in the reports before the Congress or as found elsewhere, and to defer action by the Congress on such matters until conclusions thereon may be supported by such further experience as will enable the Congress to adopt them with greater assurance as to their sufficiency.

Only the following general conclusions are therefore submitted for the action of the Congress:

1. Further experience tends to confirm the conclusion of the Congress of 1908 that the earlier results of the application of reinforced concrete to hydraulic and maritime works are encouraging, and to indicate that reinforced concrete may be expected to be reasonably permanent in sea water if the precautions necessary to secure that end are intelligently and unremittingly exercised in accordance with the best experience in such works.

2. In view of the comparative novelty of this type of construction, its increasingly wide application, and the rapidly growing experience in its use, this subject should again be made a question for consideration at the next Congress.

3d Communication: Review of Reports on Bridges and Ferry Bridges, Tunnels under Waterways Used for Ocean Navigation

GENERAL REPORT BY WILLIAM H. BURR*

While these reports disclose a fairly uniform judgment as to certain main features of the broad questions under discussion, they further show that the choice between the various proposed methods of crossing an ocean navigation waterway by land traffic must frequently, and perhaps generally, be determined on its own merits by the consideration of local conditions in connection with careful estimates of cost of construction (including land), maintenance and operation.

The main practice, both in the United States and in Europe, up to the present time has been in the direction of ferries and bridges, although within the past five years resort to tunnels has been made chiefly, but not wholly, at New York. Bridges of one form or another have been almost entirely used in Germany, France and England at points where dense ocean navigation exists, but the unsatisfactory character of such means of crossing intensely used maritime channels is becoming pressingly evident.

It would seem that the tunnels already constructed at New York, Hamburg and other points are but the beginning of further and wide choice of the tunnel plan where ocean-going traffic is materially increasing in density.

Movable bridges, such as the various types of swing bridges and bascule bridges, are available for the crossing of maritime channels where the navigation traffic and the land traffic are not concurrently dense or of large volume. If the navigation traffic is of such volume and importance that it can suffer but little interference, the method of crossing it by movable bridges is feasible, provided the land traffic is relatively light, so that the movable bridges may either be frequently opened or remain open a considerable part of the time. On the other hand, if the maritime traffic is light and the land traffic is heavy, the use of movable bridges means that the channel shall not be opened frequently nor during any considerable part of the time. Essentially the same observations may be made in connection with the transporter or ferry bridges, although a dense land traffic cannot be so conveniently or efficiently handled by them as with swing or bascule bridges. On the other hand, they are less obstructive to the movement of maritime traffic, and they afford the most direct and convenient communication between the shores of the channel without elevation of grade and with least occupation of shore space. It has been aptly said in one of the reports that the ferry bridge occupies an intermediate position between ferries and high permanent bridges.

Permanent bridges are permissible only where the vessels engaged in maritime traffic have parts not too high to pass under such structures. While, therefore, such bridges affording not more than 50 feet clear headway may pass considerable volumes of water traffic they must be and are usually limited to coastwise or inland traffic, such as along the large rivers of the United States and some of the smaller rivers of Europe.

Investigation of the utility of high permanent bridges in the reports indicates that there may be serious competition in some localities between tunnels under channels for maritime traffic and permanent bridges with clear head room enough for the highest masts of ships now found, reaching in some cases nearly 220 feet. The long ramp approaches of both tunnels and high permanent bridges constitute serious features of their construction and operation. It appears that a tunnel placed at sufficient depth to accommodate either present or future navigation traffic provided with lifts instead of ramp approaches is more economical than a high permanent bridge with the approaches required for relatively low ground on both sides of the channel. If the tunnel must be provided with ramp approaches, as for railway traffic, the choice between the high permanent bridge and the tunnel will depend upon local conditions, which must be carefully considered in making a comparison as to all the elements of the problem, including costs of construction, real estate, costs of operation, maintenance, etc. In general it may be stated that high permanent bridges possess clear advantages over tunnels only when the maritime channel lies along an enclosed valley with rapidly rising ground on either side so as to reduce the costs of the bridge approaches and the further cost of elevating the traffic on one side and carrying it down to the low ground on the other; or when the depth of water in the channel is so great that the depression of the tunnel grade prohibits tunnel construction.

The reporters do not appear to have considered the advantage of using lifts or elevators at either extremity of high permanent bridges, which obviously is similar to the advantage of the same device at the extremities of a tunnel, except that, approximately speaking, the depression of a tunnel will generally be not more than one-half of the elevation necessitated by a high permanent bridge.

The advantages of ferries, including both ferryboats for passengers and vehicle traffic and car floats for the transportation of trains of freight cars across wide channels for ocean

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navigation, have been conclusively established at New York, where enormous volumes of land traffic are transported in this way across such channels. Similar transportation by large, self-propelled car floats is satisfactorily maintained on the Great Lakes and across Detroit River in the United States. In the face of the situation, however, tunnels have recently been built under the wide channels of the Detroit River and of the East and North Rivers at New York, but thus far for passenger traffic only at the latter point. It is doubtful whether freight traffic will be accommodated under the East and North Rivers in this manner in the immediate future, although it is not improbable that tunnels for the passage of freight may be constructed in the near future.

The following conclusions may be drawn from the results of the investigations set forth in these reports:

1. Where maritime channels carry ocean navigation of large amount or of such great density as is now found in a few of the largest ports of the United States and Europe, means of crossing them must be employed which will not obstruct such navigation to any sensible extent.

2. In maritime channels where ocean navigation is of considerable volume or density, but not so dense as in the greatest ports of Europe and America, the plans for crossing those channels must be such as will give preference of right of way to the ocean navigation, *i. e.*, the service to the land traffic must be subordinated to the requirements of the ocean navigation.

3. Plans for the crossing of maritime channels which involve considerable obstruction to navigation can only be recommended where the ocean navigation is light or of small amount concurrently with a heavy land traffic of corresponding importance.

4. Channels for ocean navigation wider than about 2,000 feet offer advantageous conditions for the use of ferries, including ferryboats for passenger and vehicle traffic and car floats, either self-propelled or propelled by tugs.

5. Channels about 2,000 feet or more in width will preferably be crossed by tunnels when the ocean navigation becomes so dense as to be seriously inconvenienced or obstructed by the passage of ferryboats, or when the volume or rapidity of service required by passengers and vehicle traffic, or freight traffic, is demanded beyond that which can be furnished by ferry.

6. Movable bridges may be employed for the crossing of channels for ocean navigation when the width does not exceed about 500 feet, and if the ocean navigation is not dense enough to prevent the closing of such bridges sufficiently to accommodate the land traffic.

7. Transporter bridges may be used advantageously up to any length of span permissible for a stiffened suspension bridge even when the channel carries a comparatively dense ocean traffic, if the land traffic is not of too great volume.

8. Tunnels may be used advantageously for heavy land traffic under channels carrying ocean navigation so dense as to preclude the use of movable spans and where high permanent bridges are not permissible on the score of economy or for other reasons, or where transporter bridges are not permissible for carrying railway or other traffic.

9. The use of lifts or elevators for passengers and vehicle traffic in connection with tunnels and high permanent bridges is recommended.

10. High permanent bridges are recommended where the maritime channel is flanked by rapidly rising ground, so as to eliminate costly approaches, or where great depth of water precludes a tunnel.

11. The selection of a suitable plan for crossing a maritime channel, so located and conditioned as to make the controlling elements not so well defined as in the cases covered by the preceding recommendations, must be made after a careful examination of all the circumstances affecting the problem, including complete comparative estimates of cost covering construction, land, maintenance, operation, etc.

4th Communication: Safety of Navigation—Lighted Buoys

GENERAL REPORT BY G. R. PUTNAM*

Six papers have been presented, one on the general subject of safety of navigation and the others on lighted buoys and other aids to navigation; several of the latter papers are in effect descriptions of the lighthouse services and systems of the respective countries.

The report of Mr. G. de Joly, chief engineer of Central Service of Lighthouses and Beacons of France, deals with the illumination of the coasts of that country by gas-lighted buoys and by light-vesels. Buoys lighted by electricity or by mineral oil have not been used, but oil-gas buoys have been extensively employed. In order to increase the luminous intensity all of the oil-lighted buoys have upright incandescent mantles. This form of mantle, made of artificial silk, has been found preferable in the French service.

Some coal-gas buoys have been used recently. Tests have been made with Blau gas, but the difference in efficiency does not warrant the French service in abandoning their present oil-gas plants. Acetylene gas has not been adopted for buoys in France, but it is used for some beacons, with mantles to give an incandescent light. The life of the mantles has been found very much less than with oil-gas.

A report of the lighted buoys of the Prussian coast is furnished by Herr Regierungsbaumeister Braun, of Berlin. For these buoys oil-gas, and more recently Blau gas, have been used, the latter being preferred. A few buoys have been lighted electrically or with petroleum. Experiments are being made on the treble mirror, which has the property of reflecting back a beam of light falling on it. Several of these mirrors mounted on a buoy cause it to be visible at a distance of several sea miles by ships carrying searchlights. Suspended gas mantles are preferred. If occasion requires, the lighted buoys are fitted with fog signals, either bell or whistle. There has been in use for over a year a lighted buoy having a submarine bell worked by gas pressure from the buoy, and an unwatched lightship is now being fitted with a similar submarine signal. Extensive tests are being made of the mooring chain for buoys. A description is given of the manufacture of oil-gas and Blau gas.

The paper of Mr. D. A. Stevenson, of Edinburgh, engineer to the Commissioners of Northern Lighthouses, Scotland, states that the lighted buoy is the greatest aid to navigation produced during recent years. Some waterways, as, for instance, the Clyde, are now lighted like a street at night. Some history is given of the development of gas buoys, and mention is made of all different types of gas buoys, including the various kinds of acetylene buoys. Reference is also made to unmanned vessels having gas lights. Mention is made of the various types of flashing mechanism in connection with gas buoys, and the writer states that an automatic acetylene fog gun has lately been introduced in which the consumption of gas does not exceed that of an ordinary gas-lighted buoy, and the flash from the gun may also be used as the light for the buoy or beacon.

Mr. van Braam van Vloten, engineer to the Lighting Service of Holland, furnishes a paper on the lighting of that coast. A general description is given of the organization of the service of lighting and buoying the coasts of Holland.

In 1906 a plan was approved for the improvement of the lighting of the Dutch coast, which had previously been mainly by fixed or flash lights, using petroleum wick lamps. Four of the most important coast lights have been reconstructed with

* Commissioner of Lighthouses, Washington.

electric flash lights, and eight other lighthouses have been fitted with incandescent oil vapor lights. The illumination on several of the lightships has also been improved.

It is proposed to improve the 130 fixed and secondary lights by the introduction of either rich or Blau gas, and giving them suitable characteristics. A clockwork for lighting and extinguishing the flame has been fitted to some lights. A description is given of the new depot for lighthouse work.

There are 95 lighted buoys on the Dutch coast, all on the Pintsch system, and many of them are fitted with incandescent mantles.

Observations have been made of the visibility of lights. They prove the fallacy of the frequently repeated statement that the old petroleum lights penetrate through the fog better than the electric flash light.

A paper on the automatic lighting of lighthouses, lightships and light buoys in Sweden is presented by Mr. Grönvall, chief engineer in the Lighthouse Service of Sweden.

On account of the intricate coast the Swedish Lighthouse Department has endeavored to develop a system for automatic lighting at stations where fog signals, or a very strong light, are not needed. Pintsch buoys and calcium carbide buoys have been tried. Difficulties which were found were obviated by the use of the French invention of dissolved acetylene gas, the first trial in a buoy being in 1904. An apparatus for giving intermittent lights was invented by Engineer Dalén. The advantage of this arrangement is the light characteristic and the saving in gas. Ordinarily about one-tenth of the gas is consumed that would be required for a continuous light. Engineer Dalén has also invented a sun valve, which automatically opens and closes the gas supply in the evening and morning, and saves about 30 percent of the gas. Details are given as to gas consumption and the capacity of the gas accumulators for different classes of aids to navigation. The lanterns have been improved by an arrangement of the bars, so that very little light is lost.

The paper by Col. John Millis, United States Engineers, on the safety of navigation on the Great American Lakes, gives an analysis of accidents in connection with navigation on the Great Lakes of North America during the past ten years, and deduces therefrom suggestions toward greater safety of navigation.

The following information not covered by the papers presented is added by the reporter:

A clock mechanism has been introduced in the English Lighthouse Service for the purpose of turning on and cutting off the supply of gas for buoys and unattended beacons and light-vessels. This clock has been in use on buoys for over a year with satisfactory results.

The United States Lighthouse Service maintains at present 287 lighted buoys, the larger part being Pintsch gas buoys, and the remainder three different types of acetylene gas buoys. The great extent of the coasts to be guarded by this service makes it desirable to use different systems according to local conditions. The gas buoy has been found a very valuable aid to navigation, as it may be placed in locations where it would be difficult to maintain either light-vesels or lighthouses. In comparison with these the original expense of installation and the expense of maintenance is small, so that for a given expenditure more valuable results can often be obtained with lighted buoys.

Fifty-five of the gas buoys are provided also with sound signals, either in the form of whistles or bells. Test is now being made of a lighted buoy having a submarine bell attachment. In this buoy the movement due to the waves imparts a vertical motion to a fin and operates to store power in a spring, which, when automatically released, causes the bell to be struck. Preliminary reports from this submarine bell buoy are favorable.

Subaqueous Rock Excavation

While in Europe the use of the rock breaker in subaqueous work has been attended with some success, in the United States it has been found to give better results if a drill boat with five or six drills operating at the same time are used to drill holes for blasting. In the former case the rock for a shallow depth is broken into small pieces which can easily be handled by an elevator dredge of moderate power. Where the depth of the rock to be excavated is great it is found better to go over an area with a rock dipper two or three times, cleaning up after each time with a dredge. In the latter case the holes are drilled 5 feet below the grade no matter what the depth is, and the blasting is done so as to break up the material into pieces which can be lifted by the teeth of a large dipper dredge bucket. It may readily be seen that pieces which could not possibly be brought up with an elevator dredge can be handled easily with the dipper. The result of using the drill boat and the large dipper dredge in connection with each other is that each machine goes once over the area and entirely completes its work as it goes along. There is therefore less time lost in moving, and the work, of course, is done more economically.

On some large dipper dredges in use in the United States for subaqueous rock excavation the bail pull, or pull of the dipper by the hoisting rope, is as high as 200,000 pounds, and this pull is often concentrated on one dipper tooth, so that the pull, which can be exerted on any particular rock, is enormous. With an expert runner and cranesman on a large dipper dredge it is possible to feel around on the bottom with a dipper and determine how the large pieces lie and how they can best be attacked. This is something which is absolutely impossible with an elevator dredge.

On the large dipper dredge the large stones which are picked up come in contact only with the dipper and the dipper teeth. A spare dipper is always kept on hand and the teeth can be quickly renewed. On the elevator, on the contrary, every piece of rock which is brought up by a bucket is apt to come in contact with the lower tumbler, the sides of the ladder well, the sides of the hopper and the bottom of the hopper and chutes.

The elevator dredge operates entirely on mooring lines, which leave the vessel near the waterline, while the point of contact of the buckets with the material being excavated is far below the waterline. This makes it extremely difficult either to force the machine into the material until the machine is stalled or to regulate the strain which is thrown on the machine in getting out any particular piece.

The dipper dredge is not moored by lines but is "pinned up" by means of heavy timber legs called "spuds." In the most modern dipper dredges the dredge is pinned up by means of an independent engine, operating each forward spud so that the two spuds may be operated independently of each other. These spud engines are powerful enough to throw a large part of the weight of the forward part of the dredge on the spuds, thereby giving a solid platform and preventing the dredge from kicking back or swinging on account of the resistance offered by the material being dug.

Most of the dipper dredges used in subaqueous rock excavation have a dipper with a capacity of 6 cubic yards, although there are some of 10 cubic yards capacity, and one working along the coast of New England with a dipper which has a capacity of 15 cubic yards. This latter dredge is designed so as to work very efficiently to a depth of 55 feet below the water surface. This allows the dredge to dig several feet below grade at extreme high tide and produce a channel with a depth to grade of 40 feet.

The large dipper dredge for subaqueous rock excavation has entirely passed the experimental stage, and is now invariably used in the United States for this work.

Mechanical Equipment of Sea Port and Inland Waterway Terminals

BY H. McL. HARDING *

A terminal for waterborne freight does not consist of a pier or quay only, to or from the edge of which the ship's winch can transfer freight. To satisfy the modern requirements of freight transference there must be co-ordinated with the piers, sheds correctly designed for high tiering, car track space and dray areas, each with their respective shedded platforms and the warehouses for long storage. These should be so located, with respect to each other, that the work at each may proceed without interference from the others, and not, as is often the custom, so arranged that there should be huddled together upon the dray floor the trucks, drays, cars, held-over freight, both outbound and inbound, and, besides this, all the moving operations.

A terminal properly equipped for handling miscellaneous cargoes should have mechanical facilities for the rapid and economical transference between all the elements of a terminal and between all the freight carriers at such a terminal, whether ocean liners, coastwise ships, harbor lighters, river barges, freight cars or drays. Between all of the above elements there are the movements of freight from one carrier to the other, both loading and discharging. All such movements should be studied by engineers from actual observation before any type of mechanical equipment should be recommended.

As this paper is intended to be of general application it should be kept in mind that there are many exceptions to the general principles. As stated, the following are some of the most important freight movements, all of which should be performed by machinery, and provision for any one of which should never be neglected.

One of these is the transhipments between different steamships, as ocean liners and coastwise ships, canal or river boats. These ships are generally located at different piers or remote quays, and the transference is chiefly effected by means of lighters, which are the water drays, but having a carrying capacity of 400 to 600 tons, instead of the 2 to 4 tons of the land drays. The lighter is the economical means of harbor transport. It is not practicable for a large steamship to call at different piers to receive or discharge portions of miscellaneous cargo. This is largely the lighterage service.

The cargo from a foreign or coastwise steamship may be for a dozen or more different water or rail connections about a port. This cargo consists of cases, boxes, barrels, bales or crates, and the same draft from the hatch often contains different marks, which must be separated and inspected before each can be routed for its destination. It is therefore necessary with such freight that it pass upon or over the pier. Provision should therefore be made in the design of a pier of the jutting or projecting type, for the berthing of a number of lighters at the same time and the corresponding mechanical equipment.

PRESENT APPEARANCE OF RIVER LEVEE

At the port of New York these lighters are from 80 to 100 or more feet in length, and require one or two men. When loaded they are generally towed by tugs about the port. The average rate for these harbor tugs is about $10 (£2 1s. 8d.) an hour. This may be for a lighter load of 600 tons. The rate of a two-horse dray averages $1.00 (4s. 2d.) per hour for 2 tons.

One approved method of berthing is for the steamship to be upon one side of the pier and for the lighters to be on the other, and also fore and aft of the ship, if there be any space there. While much of the outgoing package freight can be loaded over the ship's side yet not more than 10 percent of the inbound freight is thus transferred. Portions of the cargo may be for warehouses located at other terminals, and this transport also should be by lighters. In some instances as many as forty lighters are congregated about a single pier, and sometimes in three parallel lines.

From the cursory description of lighterage the necessity for providing machinery for the movements between steamships and lighters is self-evident. Very wide piers with two rows of sheds, with cars or sheds between, seriously interfere with lighterage. This has been proved by experience and it is well

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known to every terminal agent. It is desirable to keep the pier floor as clear as possible for the inspection, routing and the temporary holding of the freight.

Inbound freight often should be taken to the bulkhead shed, even to the second story, when it is to be held only a short time over the free storage period, and it is not desired to have incurred the warehouse charges. This is often granted as an accommodation to large shippers and consignees. On account of the great expense of handling, or rather rehandling, freight is frequently suffered to remain upon the pier floor, though in the way, and sometimes it is necessary to move it several times. This generally happens when the stevedore is selecting freight of different kinds for proper stowage.

The next important transference is between the vessels and cars, or rather the car platforms, as in the United States the box-car is almost exclusively used for package freight.

When the hand-truck was used in freight handling on or about the piers, to reduce the hand-trucking distance it was deemed advisable that the cars should pass upon the piers. There was this great disadvantage in this that the cars occupied valuable and expensive pier floor space which should have been reserved for freight storage. It also prevented direct movements across the piers. Upon many of the piers at the port of New York such car tracks, though formerly laid, have now been removed.

Another disadvantage of having the cars upon these projecting piers is the dividing of the pier into sections by depressing the tracks so as to have the pier floor and the car floor upon the same level. This means that the cars must either themselves constitute bridges or else movable lifting bridges must be provided, which are unwieldy and cumbersome, and must be removed during car shifting. Where there are two or more lines of tracks the condition is worse

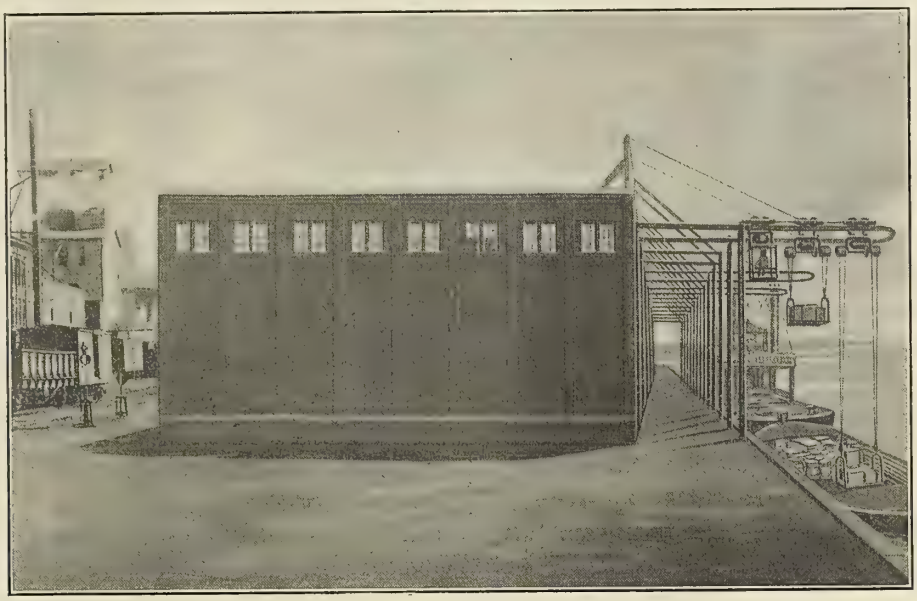
If the car tracks and the pier floor are upon the same level, freight must be lifted about 4 feet when placed in the car or upon a movable platform in front of the car door.

It is preferable to run the tracks at right angles to the pier length but close to the head of the pier upon the shore, the same as is the custom where there is a continuous quay wall similar to the track arrangement at many European ports. Between each parallel line of tracks there should be a platform which here can be made level with the car floor without detriment. The freight movement between the vessel and the thus located car platforms should not only receive attention but also the movements between any portion of the pier floor and these platforms, as it often happens that cars for certain cities are not available, and the freight, though eventually for the cars, must be held upon the piers.

The third movement is between the vessels and the dray areas and platforms. In many cases, especially with outbound freight, the drays may pass upon the piers, and arrangements should be made for this, but so much of the pier floor would have to be reserved for this purpose it is better wherever possible to avoid it, as being able to unload upon platforms instead of upon the floor is advisable.

The dray area should therefore be placed to the rear of the car tracks. By means of a correctly designed system of mechanical transferring, this freight also can be handled economically and expeditiously. The advantage is especially marked in connection with the local inbound freight, which can be routed at once to these dray area platforms.

The outbound freight, instead of being dropped, as is the custom, often 10 feet from the top of a drayload to the pier floor, or to minimize the breakage directed to strike the dray wheel in its descent, is unloaded upon flatboards placed upon the platforms, or may be taken from the dray to the vessel or to the space upon the pier floor near the hatch. If placed upon flatboards upon the platforms the flatboards with their loads are carried to the vessel.



RIVER LEVEE IMPROVED. HINGED LOOPS EXTENDING OUT OVER THE BARGES, TRANSFER TRACTORS WITH HOISTS RAISING THE LOAD

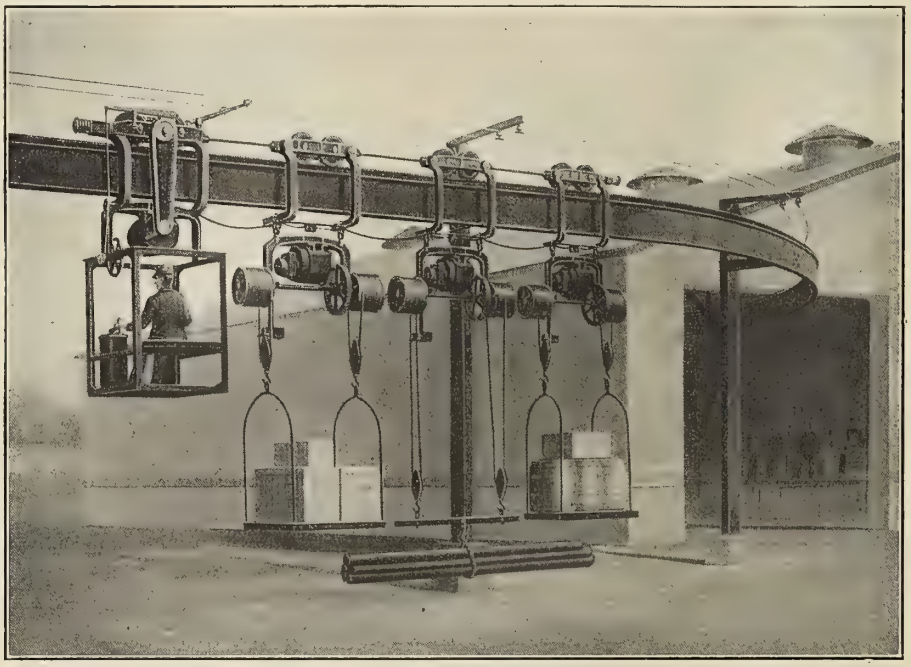
The freight-holding capacity of a pier can be doubled if drays are kept off the pier floor. The inbound freight can be taken from the vessel from the ship's fall or from the side of the pier to the inbound platform in the dray area by one movement without interference or rehandling.

From these platforms the freight can be taken by the drays for local destinations without interfering with the ship's loading or discharging. The freight, however, can only be economically transported by the installation of long-distance hoisting and conveying machinery.

The warehouse constitutes an essential element at all terminals. Inbound freight must be moved from the pier after being held a limited time, the rule often being after forty-eight or seventy-two hours. This time limit is necessary to prevent congestion on the piers or on the quays. In the movement between the pier or the vessel and the warehouse it should be possible to transfer the freight even to the second or third story of the warehouse.

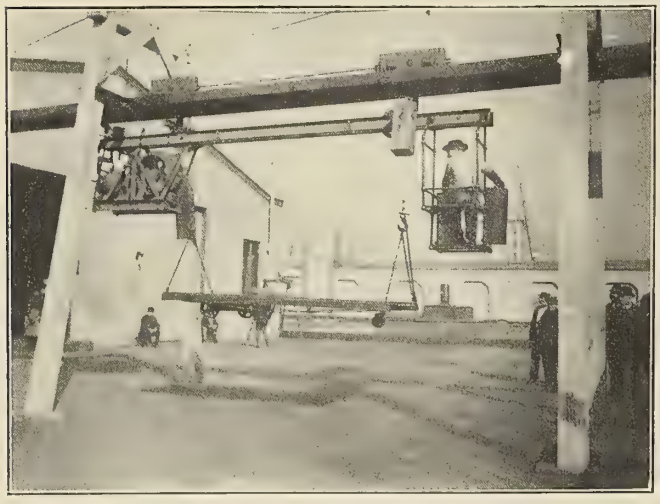
There are therefore at seaboard terminals six principal

freight movements and the corresponding reverse movements. A careful study of all the present methods of freight handling indicates most conclusively that any system to be successful, and to avoid expensive rehandling, must be a combination of hoisting and conveying. It often happens that the lifting is equally important with the conveying. This hoisting is necessary that the machinery may be able to elevate the loads so that they can pass over intervening obstructions and serve different levels, and also avoid the reserving of valuable floor space for traveling.



THE TRANSFER TRACTOR AND THREE TRAILER HOISTS. EACH HOIST RAISES A SEPARATE CONSIGNMENT

Harbor improvements are exceedingly expensive, and to build more piers or quays which would be used for surface conveying hardly seems like economy, especially as the conveying by the later types of machinery can be overhead and without interference, practically continuous.



OVERHEAD TRANSFERRING AND HOISTING MACHINERY

To secure anywhere near the capacity of a pier there should also be high tiering. Five feet is the usual average height of tiering by hand. If this average can be increased to 15 feet, the holding capacity of a pier is tripled; and if to secure this capacity little or no floor space is occupied in the conveying, there would be eliminated floor interference or congestion.

Any machinery should be able to fulfill economically and with rapidity all of the above described freight movements between the vessel, the lighter, a remote portion of the pier or bulkhead, the car or dray platform and the warehouse. These movements should be approximately in circuits or loops, regardless of surface obstructions, the loads being conveyed without interference with each other.

The conveying and hoisting machinery in its operation should not be compelled to wait for the loading or unloading of flatboards, nets or other carriers. That which contains the load should be independent of the tractor unit, just as a locomotive is independent of the freight cars.

Not only must the same machinery hoist and convey but it should be able to distribute and assort. To accomplish this the consignments should be kept separated according to the marks when being hoisted and conveyed.

Where desired the ship's winches can hoist the loads from the hold, and place them upon the vessel's deck or upon the side of the pier, the rest of the transferring being by means of the overhead carrier. The overhead hoisting and transferring mechanism can, however, perform all the movements.

That method of hoisting and conveying which seems to be of the most universal application is what is known as transference, and consists of overhead tracks or runways, some of which are fixed and some movable.

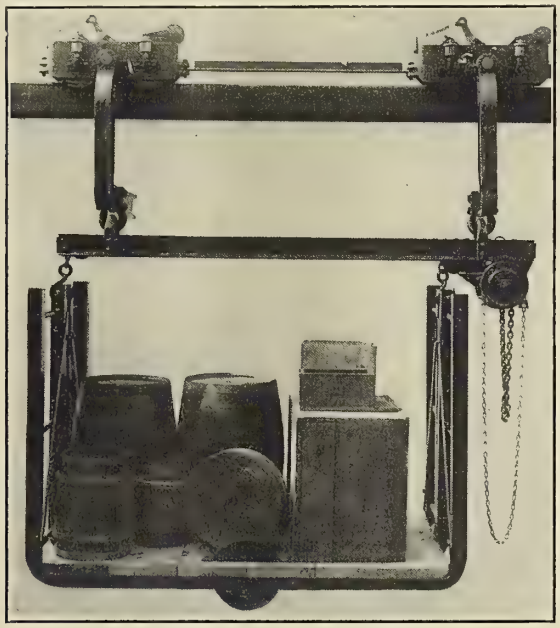
Suspended from these tracks is the conveying mechanism. This consists of trains composed of a transfer tractor or electric conveyor, which draws after it a number of transfer trailers. From each of these trailers is suspended an electric hoist. One man in a cab controls the conveying and hoisting.

Of the movable tracks, some are in the form of loops, and other tracks are attached to traveling cranes, and are connected with the side tracks by gliding switches. By these tracks every cubical foot of space can be served, either the hatches and decks of the vessels or the pier floor, the car or dray-area platforms or even the warehouses.

The loads, kept separate as to consignments, can be hoisted from any place on the terminal and conveyed to any other

place by one transferring movement, loads following one another continuously. All of the above movements are affected without rehandling by manual labor.

The above may be said to be the latest advance in terminal cargo transference. Long-distance transferring machinery, independent of levels, greatly simplifies the design of port terminals. By avoiding rehandling there is less breakage, greater rapidity of transference and less expense. Even rehandling costs at least 15 to 20 cents (7½d. to 10d.) per ton for labor only. By confining the movements to the overhead there is not the congestion or interference which may be observed to be the usual condition at large terminals. The loads can be placed upon car or dray-area platforms a thousand or more feet from the pier as easily as upon the opposite side of



DETAILS OF TRAILER AND TRUCK

the pier. It costs little more to transfer by such machinery 1,000 feet than it does 500 feet, and no more to tier than to place upon the floor.

By being able to transport the freight without a material increase in cost to areas or warehouses at the rear of the piers, or even to places removed from the waterfront where land is economically available, means a great increase in the capacity of a terminal, and far less expenditures for the port development. This one feature of increased capacity would reimburse by many times any expenditure made for the mechanical installations. Besides the economies secured substituting such machinery for manual labor, there is also greater rapidity in loading and discharging.

The machinery which has formerly been employed for handling general cargo in addition to the ship's winches consisted chiefly in some form of the traveling gantry crane. The development of these cranes has been in the direction of obtaining greater range, thereby clearly recognizing their limitations. Their range has been within a radius of 50 feet from the edge of the pier and that opposite the hatch which they were serving. As they are unable to transfer the goods "up and down" the pier, or to any distances within the pier shed, this work has generally been performed by manual labor. The relative proportion of costs of these two movements are 3 cents (1½d.) per ton for the ship's winch or gantry crane and 30 cents (1s. 3d.) for the later manual labor.

The advantages of the recent improvements in mechanical transference over the present primitive methods therefore may be summarized:

A reduction in terminal handling costs to at least one-half, and a similar saving in the time of ship detention.

Increased storage and transferring capacity of terminals.

Saving in port investment.

Better service to the shippers and consignees.

Less losses from breakage and damage claims.

Avoidance of labor troubles and a better utilization of lands for industrial and manufacturing purposes though located several thousand feet to the rear of the waterfront.

The terminals for inland navigation, especially on the rivers, should be of quay-wall construction or else of wood or concrete piles. There is often a great variation, as upon the Mississippi and its tributaries, between the high and low-water levels, and this should receive consideration in the design of such river terminals and the kind of machinery to be installed. In most cases overhead runways equipped with transfer tractors and transfer trailer hoists above described will best fulfill the requirements, as by this class of hoisting machinery the height of the river does not effect the transference, the difference between high and low water meaning only a few feet more or less of hoisting.

Quarterly Report of Progress of U. S. Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.
Wyoming	27,000	20½	Wm. Cramp & Sons	97.0
Arkansas	27,000	20½	New York Shipbuilding Co	96.0
New York	28,000	21	Navy Yard, New York	35.3
Texas	28,000	21	Newport News Shipbuilding Co	61.9
Nevada	28,000	20½	Fore River Shipbuilding Co	0.0
Oklahoma	28,000	20½	New York Shipbuilding Co	0.7

TORPEDO BOAT DESTROYERS

Fanning	742	29½	Newport News Shipbuilding Co	89.9
Jarvis	742	29½	New York Shipbuilding Co	80.2
Henley	742	29½	Fore River Shipbuilding Co	75.1
Beale	742	29½	Wm. Cramp & Sons	78.9
Jouett	742	29½	Bath Iron Works	97.9
Jenkins	742	29½	Bath Iron Works	93.3
Cassin	742	29½	Bath Iron Works	15.6
Cummings	742	29½	Bath Iron Works	15.5
Downes	742	29½	New York Shipbuilding Co	10.7
Duncan	742	29½	Fore River Shipbuilding Co	18.1
Aylwin	742	29½	Wm. Cramp & Sons	18.4
Parker	742	29½	Wm. Cramp & Sons	16.4
Benham	742	29½	Wm. Cramp & Sons	17.1
Balch	742	29½	Wm. Cramp & Sons	14.4

SUBMARINE TORPEDO BOATS

F-1	....	....	Union Iron Works	96.6
F-2	....	....	Union Iron Works	92.7
F-3	....	....	Seattle Con. & D. D. Co	91.3
F-4	....	....	Seattle Con. & D. D. Co	90.6
G-4	....	....	Wm. Cramp & Sons	73.5
G-2	....	....	Newport News Shipbuilding Co	85.8
G-1	....	....	Lake T. B. Co	90.2
H-1	....	....	Union Iron Works	66.3
H-2	....	....	Union Iron Works	66.5
H-3	....	....	Seattle Con. & D. D. Co	63.6
G-3	....	....	Lake T. B. Co	46.6
K-1	....	....	Fore River Shipbuilding Co	30.8
K-2	....	....	Fore River Shipbuilding Co	30.1
K-3	....	....	Union Iron Works	36.6
K-4	....	....	Seattle Con. & D. D. Co	30.2
K-5	....	....	Fore River Shipbuilding Co	13.5
K-6	....	....	Fore River Shipbuilding Co	13.5
K-7	....	....	Union Iron Works	17.5
K-8	....	....	Union Iron Works	17.5

COLLIERS

Proteus	20,000	14	Newport News Shipbuilding Co	54.8
Nereus	20,000	14	Newport News Shipbuilding Co	46.9
Orion	20,000	14	Maryland Steel Co	77.1
Jason	20,000	14	Maryland Steel Co	36.9
Jupiter	20,000	14	Navy Yard, Mare Island	62.0

The Spanish drydock, capable of accommodating vessels of 12,000 tons gross register, which was captured as a prize by the United States during the Spanish War, has been towed to New York from Pensacola, Fla. The dock will go into commission in the New York harbor for the service of the United States Government.

Inland Water-Borne Commerce in the United States

BY JOHN RUDDLE, M. E., C. E.

Inland water-borne commerce in the United States is in a state of arrested development because it so happened that, in the development of the human race, the railroad, as a means of transportation, arrived at a sufficient state of perfection to carry traffic economically before the great development of farming, mining and manufacturing took place. When they were to be developed the railroads were ready to serve them. In fact in many instances, long before the industrial development took place, the railroad was there ready for service. The consequence was that all developments that required transportation facilities took place along the railroads, rather than along the rivers, and caused the railroad traffic to develop instead of the water traffic. In this respect the situation in the United States is directly opposite to the situation in Europe and other countries where the need of transportation developed earlier than the development of the railroad. This historic fact seems to be forgotten or ignored when comparison is made between the backward development of water transportation in the United States when compared with Europe.

Not only is this historic fact ignored, but it seems to be assumed, or at least the element of time is ignored when the assumption of certainty is made, that when the rivers and water courses are "improved" water-borne commerce will immediately grow to large proportions and will warrant the expenditure of indefinite sums of money to make the development.

The water-borne commerce of Europe is not the result of sudden growth, nor is the tremendous rail traffic in the United States. Both are the results of years—yes, generations—of cultivation and development and water-borne commerce will come, if it comes at all, only as the result of long years of growth.

There is also a reasonable doubt whether water-borne commerce in the United States will ever reach the relative importance it has in Europe on account of the geographic location of the rivers which must form the basis of the improved waterways. The main mountain ranges, that form the divides between the important valleys, lie in a generally northerly and southerly direction, whereas the seaports from which commerce leaves and enters the country are on the East and West coasts, so that the lines that commerce must travel to and from the main seaports and the center of the country are approximately at right angles to the courses the main rivers follow. This condition in itself will always operate to render ineffective, to a certain extent, all efforts to develop a water traffic that will reach the relative importance that it reaches in Europe, unless, by some herculean effort, commerce be induced to abandon the Atlantic ports for those on the Gulf coast.

Other conditions exist that also emphasize the difference between the two territories. In Europe the improved waterways are largely the result of efforts made directly by those who desired to use them—cities, States and corporations, and when they had expended energy and effort in making the improvements they used them and maintained them, and they became a vital part of the industrial development of the country, and the industries and communities taxed themselves directly for their construction and support. In the United States, however, it is the general government that is expected to build and maintain the waterways out of moneys raised from indirect taxation, so that no part of the community can feel a direct interest by reason of having spent its own money and effort. As a consequence there can never be any strong feeling of pride on the part of any community in the development and use of the waterway. The only incentive to use it will be the one of profit, and that takes in so many considerations that in only exceptional cases will the expenditure of money for improvements be warranted.

But the improvement of the rivers for navigation will come and should come, because, though they may not be necessary at the present time or for many years to come, the time will come, when the density of population approaches that of Europe, when the railroads will be only too glad to be relieved of handling a large amount of traffic they are now glad to carry, and the improvement of the rivers might just as well be made now as at any other time, especially as in after years there may be no River and Harbor Bill to provide funds.

When these various improvements are undertaken, it should be clearly understood that the improvements will not become self-supporting immediately and that, until they do, the necessary funds for maintenance must be borne by the general taxation. If the work was being done by a corporation these funds would be supplied by increasing the amount of the bonds issued against the work, and then a failure to earn the interest charges within a reasonable time would be followed by bankruptcy.

Assuming, however, that the streams are to be improved, it remains to be determined how it can best be done and what amount and kind of work will be the most efficient and the most economical.

In the direction of efficiency the improvements should be made so that they will be available for use by the greatest number; they should not be made for the capitalist, who can command wealth enough to build steamboats, to the exclusion of the man who, from necessity or choice, wishes to use a small boat and move it by towing with a horse or mule. The improvements should be made with a view to the joint and simultaneous use by boats of all suitable sizes, by whatever power they may be moved. This of course means that wherever practicable proper towing paths and lateral roads must be provided for, and these will be especially useful in developing the traffic that moves only short distances. This short distance haul, by the way, will probably, in the course of time, assume large proportions in the aggregate. It will be traffic handled by farmers and those desiring to conduct a small transportation business for hire, who will handle largely farm products to nearby points of consumption, and fertilizer or other commodities in return, thus enabling the markets in the towns to be supplied at a lower cost. Or the farmers, or others, may handle their products from the farm to some point where shipping facilities to more distant points are better, or from which a better market can be reached. This condition will apply especially to canals passing through agricultural countries or where small manufactures are carried on, and where the available tonnage or the possible rates would not warrant the installation of more elaborate transportation facilities at the beginning.

Any improvement, therefore, made at the expense of the general taxpayers should contemplate the use of the improved waterway by all classes of traffic or it will fail of its most vital advantage, that is, the greatest good to the greatest number.

Improvement of Rivers

The manner of improving any river will be determined by the character of the river itself and the nature of the country

through which it flows. If the stream is characterized by very great variations in the amount of water it carries, that is, if at certain seasons there are high floods and at other periods extreme low water, a system of reservoirs to control these conditions will be absolutely necessary. They will be needed, first, to hold back flood water and reduce the amount of damage that may be done to the improvements by floods, and, next, to supply the deficiency of water during the periods of extreme low water. It will be necessary also to provide the necessary means to control the water at all points of the river during low water periods, so that none of it will be wasted and the fullest benefit will be obtained from all the available water in carrying traffic. As water is the *sine qua non* for water-borne traffic, this is the very first question that should be considered in determining the method of improving any river, because this condition is controlled by the laws of nature while all others are in the control of man and may be rectified by a greater or less expenditure of money and effort, but no amount of money or engineering ability can control the rainfall.

Of course as an academic question it may be asserted that even the water supply of any stream can be controlled by pumping the water from another stream, but the mere assertion of the question emphasizes its absurdity from an economical standpoint.

The available water supply having been determined satisfactorily a study of the stream and the character of the country through which it flows will determine the character of the improvements that will best suit the individual case, and every river will have to be treated as a case by itself. In a general way improvements that will be suitable for any one river will not be suitable for any other river except with such great modifications that render each a case by itself.

Rectification of the Natural Channel

Where the particular conditions applying to any stream permit it, this is obviously the most effective and cheapest means of improving, because it involves less expense for maintaining the improved channel and a less cost of operating, there being no locks or similar works that require the continual attention of labor.

Among the conditions controlling the rectification are the normal velocity of the stream, which is controlled by the slope of the bottom and the volume of water carried. Where the normal velocity is low the difficulty of navigating against the current is reduced and the danger of interference with the improved channel by silt carried by the water or by scouring of the banks is reduced to a minimum. The rectification will usually be accomplished by protecting the natural banks at points where they are exposed to the force of the current so that they will not be eroded and the material carried into the channel. This work will be particularly necessary on the outside of the curves at bends in the river, but it will also be necessary at some points at the inside of the bends where the ground is low and there is danger at times of high water that a new channel may be cut across the lowland. Dikes will have to be constructed at such places to prevent overflow.

In some cases where the land is low and the character of the material permits, it will be more desirable to open a new channel across the neck of land and turn the entire stream through it by means of a dam, thus straightening the channel and, usually, by reason of the slight increase of velocity secured, making a channel that will keep itself clear by the scouring action of the water. The material excavated from the new channel will naturally be used to build up the banks and prevent the flooding of the surrounding country.

Sunken trees, loose rocks and other submerged obstructions will have to be removed, and when this, together with what has already been stated, has been accomplished, the simplest and cheapest method of river improvement will have been completed and the natural channel made as navigable as circumstances permit.

Dredging

If greater facilities are required dredging the natural channel will have to be resorted to. If the bottom of the river is of alluvial material this can easily be accomplished and the dredged material can be used to build up the banks at certain points, narrowing the channel and by the increased velocity obtained increasing the scouring action of the stream, either increasing the depth of the improved channel or preventing it from being filled up with silt. It will never be necessary to dredge the full length of any river, as there will always be some points where the natural depth will be sufficient for navigation. It will frequently happen that at some points ledges of rock form obstructions to the improvements. These will have to be removed by blasting unless they are very long, in which case some other method of securing a channel will be indicated.

A controlling factor in improving a channel for navigation by rectifying it is, will the channel after completion maintain itself or must it be maintained by continual attention and repair and renewal of the work that has been done? This will depend largely on the character of the stream itself with regard to the variations in the height of the water, the material composing the bottom of the river and the nature of the banks. If the bottom is composed of light material easily eroded the scouring action of the stream at high water may be depended on to maintain a good depth of water at most points. If the banks are high and composed of material not easily eroded they will confine the water during flood periods and increase its scouring effect. These banks may be either natural or a part of the original design for rectification. Any stream, however, that carries a large amount of solid material will fill up its channel at some points, and provision must be made for maintaining the channel at these points by periodic dredging.

Usually in the improving of a channel by dredging, the disposal of the dredged material, so that it will not find its way back into the channel, becomes a most serious problem. It can be taken from the bed of the channel cheaply by any of the well recognized methods of dredging, but it requires special and expensive equipment to finally dispose of it. If lowland nearby is available it may easily be disposed of by hydraulic dredging and using the material to build up the banks, rendering them less likely to be overflowed during high water, but where such land is not available the material may have to be transported long distances and disposed of by specially designed machinery.

This disposal, together with the character of the bottom of the river, whether it is largely composed of rock or not, and the slope of the bottom controlling the natural current, will be the deciding questions as to whether the improvements shall be by improving the natural channel or by securing the desired depth by means of dams and locks, or by lateral canals, or by a combination of both. A rapid current in the river combined with long periods of low water and rocky bottom will indicate that the desired improvements can best be accomplished by canalization, and by canalization will usually be understood that certain portions of the natural stream will be improved by dams and locks, and these connected by sections of lateral canal of greater or less length, according to local conditions.

The Use of Dams and Locks

Where the bottom of the river is largely composed of rock in ledge it will usually be found that the required depth of water can be more cheaply secured and maintained by means of a dam and lock, even considering the upkeep and operation, than by dredging, and where the slope of the river bed

causes a high velocity a dam and lock becomes imperative. The dam will be built sufficiently high to create a pool of sufficient depth extending up stream far enough to reach water of the necessary depth in the natural or otherwise improved channel. If this distance should be so great that the dam and lock become of an uneconomical height, two or more dams must be used.

Where two or more dams are required and the nature of the surrounding country permits it, it will usually be found that a stretch of lateral canal will be the cheapest because a considerable distance may be saved, the locks will be of less expensive construction and the banks will probably cost less than the series of dams. Maintaining and operating expenses also enter into this determination. The danger of destruction or damage by flood is less in the case of the canal than in the case of the dam; the canal will not be filled with silt from the river requiring dredging; the canal furnishes a convenient harbor of refuge for traffic during flood in the river, and a most convenient location for docks and other accessories to navigation where their operation will not be interrupted by variations in the height of the water in the river.

As against these advantages there is the cost of maintaining and operating the locks and their accessories. These, however, are not of such expensive construction, nor do they require such careful maintenance as locks in the dams built in the river proper. Also the current through the various levels being at all times uniform the traffic is under better control, and what it loses in not having the assistance of the current in one direction it more than makes up in not being obliged to move against a strong current in the opposite direction. It is hampered, however, by the inability to move at high speeds incidental to navigation in narrow channels.

Works of this kind are of the most permanent character. When properly constructed at the beginning they do not depreciate. In fact, the longer a canal bank stands the better it becomes and the less maintenance it requires. Also the artificial bank makes the best possible location for the towing path and, as the artificial channel will usually pass through agricultural lands, it becomes possible for the individual farmer to have his own loading place and handle his products at the lowest possible cost.

Dimensions of Canals

The dimensions that will be given to any canal and its accessories will depend entirely on the volume and character of the traffic that it is designed to carry and the distance it is to be moved. If there is a great bulk of low class traffic such as coal and ore, to be moved for long distances the canal should be large enough to accommodate the largest size of boats than can be economically operated provided the cost of building the canal is not excessive and the available supply of water is sufficient. If, however, the volume of traffic, though it may be large, yet is made up of a great variety of commodities or moving short distances, the canal can be made very much smaller with decided advantage as to cost of construction, maintenance and operation, and the boats that will be used will be of smaller and cheaper construction, thus enabling people of small capital to own boats and operate on the canal, making it more generally useful.

Another factor is the method of moving traffic in the canal or waterway. Is it to be moved by animal towage or mechanical towage from the banks by towing-boats or are the boats themselves to be equipped with power? The ideal canal is one where all three of these methods can be simultaneously used, but this also assumes that much of the traffic is to be moved long distances, because the towing-boats cannot be used to advantage for short distances. The economical size of boat will be the one which permits the movement of the maximum number of tons with the minimum labor. The minimum labor is probably two persons for a single boat. From the writer's experience he knows that a boat carrying 100 tons and manned by two persons is not economical in the coal carrying traffic. This same force could as easily handle a boat carrying 200 tons moved by animal towage and worked 12 hours per day without detriment to either men or animals, so that this may be considered the minimum size. The maximum size will be controlled by the greatest tonnage or cargo that can be carried per man of the crew and the economical depth that can be secured in the channel. This in the estimation of the writer will be somewhere between 7 feet and 10 feet; the beam and length of the boat will then be determined by the amount of cargo that it is desired to carry.

It is not economically sound to design a canal or river improvement that is to depend for its traffic on the products or industries within easy reaching distance for boats of large capacity. Nor is it sound to design for boats of very small capacity. The canals and river improvements made under the various internal improvement acts by the various States early in the nineteenth century, with the exception of the work on the New York State canals, were on too small a scale to be economical for permanent use, but at the time they were equal to all demands. Had they been built on a more extensive scale the cost would have been so excessive that they could not have been undertaken. They served their purpose well, and in the case of New York it has been deemed advisable to spend large sums for increasing their capacity. In the meantime, however, they have demonstrated their usefulness. In the case of the other States the canals have practically gone out of existence from various causes, the chief of which has been the failure of the people to appreciate their advantages and their consequent failure to maintain, protect and improve them. It is submitted, therefore, that in the design and construction of new canals and river improvements it is truer economy to design and build for a comparatively small capacity of boat, paying careful consideration to future enlargement after the traffic has grown sufficiently to warrant it, after the country through which it passes has developed in either agriculture or manufacture, or both, to a sufficient extent to produce traffic sufficient to warrant the expense. This is the course that has been unconsciously followed by the European canals, and also by the railroads in the United States, which now, after the generations they have been in operation, find it necessary to double track, relocate and regrade in order to increase the economy of handling their traffic. In the meantime, however, their original cost has been earned many times over, and they have demonstrated their usefulness.

In the design of new river improvements or canals, therefore, a valuable lesson may be learned from the history of railroad development. This is in no sense an argument against the development of water transportation, but it is an argument to go slow, study the question from an economic standpoint and design for present needs and the needs of the near future, letting the more distant future take care of its own problems, and make such improvements and enlargements as experience proves to be both necessary and desirable. There is no good reason why the present generation should spend money lavishly to make developments for future generations, loading them up with debt that they must pay, when there is a possibility that the work may be abandoned entirely, just as has happened in many cases with the improvements in river and canal navigation made in the early part of the nineteenth century already referred to. In some cases, no doubt, the present generation is still paying the interest and is responsible for the principal of the internal improvement

bonds, as they were called, issued to pay for "improvements" made nearly a century ago and now gone out of existence. The reason for the disappearance is immaterial.

PRINCIPLES OF OPERATING

As before stated, the design of any river or canal improvement should have in view the simultaneous use by boats of all sizes that can navigate it, no matter by what means the boats may be moved.

The historic way to move boats on canals is by animal towage, and this presupposes boats of small capacity or very slow progress, or both, and is consequently not economical; and yet it is the only means available to the individual of small means.

Little effort was made to improve the methods of towing boats from the shore until after electricity became available as a source of power. Since then a great deal of thought and a great deal of money has been expended upon the problem, but not with any great amount of commercial success. The towing can be done successfully and with great economy, but the cost of installing the necessary equipment is so great that interest and depreciation far outweigh the economies in towing. The literature on the subject of electric towing on the European canals is very voluminous, but little has been done in that direction in the United States except in the way of experiment in three cases, none of which developed a sufficient certainty of commercial success to warrant any extensive installations.

The advantage in towing boats from the shore rather than from a floating towboat is that there is little or no "slip" as compared with the screw propeller or paddlewheel, and consequently the power is used to a greater advantage. The only disadvantage, aside from the cost of installing the towing plant, is the necessity for a towing line reaching the shore; but this in practice is not serious. The requirements of the towing machine are that it must be able to operate continuously and economically at all speeds, below the maximum, down to a slow walk, because the requirements of canal navigation necessitate that the craft must be under control at all times. It must be "fool proof," because it must be operated by the cheapest possible labor. It must be cheaply constructed and not liable to breakdowns, because it will be usually far away from facilities for repair and rather difficult of access quickly, and, of course, it must be weatherproof and it must be capable of exerting its maximum power at very low speeds, because the greatest power is required in starting the boat.

It must operate on some sort of a track or permanent way. All attempts to tow boats by machines operating on the towpath or other similar road not designed to keep the machine in a predetermined path have been miserable failures. The permanent way must be cheap to install, easy to maintain and not liable to damage by water in case of overflow in times of flood. It must be possible to construct and maintain it without interfering with the maintenance of the banks of the canal, the repair of leaks and so forth, and must not prevent access to the waterway for the purpose of loading and unloading boats with a reasonable degree of economy and convenience.

It is not the purpose of this article to go into the discussion of electric towing of canal boats so we will be content with giving the specifications of the requirements and leave it with the remark that it will never be economical to install electric towing until the density of traffic on the waterway far exceeds any so far attained in the United States on any waterway.

The only other means of towing boats and avoiding the use of animal power is by the use of floating towboats. These may be of two general kinds. One a towing boat equipped with power and designed to pick up a chain or rope anchored at either end and lying in the bottom of the waterway and moving the boats by pulling against the chain. Such boats are used successfully on some European waterways, but have never been used in the United States.

The only other kind is a boat equipped with some sort of power and moving by means of a screw propeller or side wheels. Boats of this class with steam as a motive power are too common to require any attention.

Attempts have been made in an experimental way to substitute electricity conducted from a wire suspended over the waterway to the boat for steam, but it has never been commercially successful. A suggestion has been made to equip a power boat with electric machinery and conduct the current through a species of tow line to boats following it, equipped with motors and screws, but this has never been put in practice.

The most promising substitute for steam to operate towing boats is probably the internal combustion engine operated either by gasoline (petrol) or by producer gas, the latter will probably prove the most economical on account of the cost of the gasoline (petrol).

In order to satisfy himself that an internal combustion engine operated by producer gas could be used for navigation purposes the publisher of this journal, in the summer of 1910, equipped a small boat with an internal combustion engine and a suction gas producer and operated the boat experimentally during the entire year, securing some valuable information, and demonstrating that such an equipment was practicable and economical. Later several barges with a similar equipment were built at Baltimore and are now in operation successfully. In the summer of 1911 the Lehigh Coal and Navigation Company, which operates a canal in Pennsylvania, caused two towing boats to be built equipped with gas engines and suction gas producers and operated them as towing boats in its canal with a considerable degree of success. These boats were equipped with 54-inch suction gas producers to use anthracite coal and four cylinder engines that at 300 revolutions produced 70 horsepower. The propellers were 52 inches in diameter and 32 inches pitch. The average revolutions during operation were 280 per minute, so about 65 horsepower was developed under operating conditions. The hulls were 42 feet long and had 10 feet beam and drew 54 inches. The canal where they operated has a minimum width at the surface of about 60 feet, and at the bottom about 20 feet; the depth is about 6½ feet. The boats were loaded to the depth of about 63 inches. They have a beam of 10½ feet and a length of 88½ feet, and carry a cargo of about 96 tons, average, and the boats themselves weigh about 22 tons, making the weight of boat and cargo 118 tons. Attempts were made to attain a speed of 3½ miles per hour towing loaded boats with these power boats, but they were unsuccessful even with two towing boats aggregating about 130 horsepower. Tows of from 4 to 6 loaded boats, however, were successfully towed at a speed of about 2½ miles per hour under operating conditions with a single power boat. These figures illustrate clearly the tremendous expenditure of power necessary to move boats through the comparatively restricted channels of artificial navigation and the great waste of power in attempting to do so by any of the usual kinds of power towing boats.

It will be interesting by way of comparison to state that the writer in some of his own experiments towed the same boats similarly loaded on the same canal under similar conditions by an electrically operated device at a speed of 4½ miles an hour with the expenditure of about 35 horsepower, illustrating the great advantage of having a practically fixed point against which to exercise the pull and the advantage of towing from the shore over towing by floating craft.

The navigation of the narrow shallow channels of canals at high speeds makes some method of protecting the banks imperative. The damage caused by the boats moving at high

speeds does not come from the propellers of the towing boats but from the bluff bows and square sterns common to canal boats. These waves are caused directly by the speed at which the boat is moving, and the damage is done near the surface of the water where the protection must be put. This protection is most effectually and economically secured by paving on the slope of the bank, carrying the work well toward the bottom of the canal and, of course, should be placed wherever the material is of such a character that it can be damaged by the wash.

In view of the above experiences it would appear that the most serviceable canal to the public at large would, when the traffic becomes sufficiently dense to warrant the investment, be one equipped with some form of towing device traveling on the shore and towing any and all boats between all points for a charge that would be the same per ton to everybody.

A very economical method of handling traffic is to navigate canal boats in fleets, following the practice in use for many years on the Erie Canal in New York. On that canal one canal boat is equipped with a steam engine and screw propeller which, of course, takes up some of the cargo capacity. A second boat is placed immediately in front of the power boat and close to it in such a manner that the stem of the power boat bears against the stern of the forward boat, being connected so that the two boats move on each other after the manner of a hinge. A device is placed on the leading boat by which the power boat may be swung from side to side, and the steering is performed by this movement. Very little power is used to steer in this way, and the two boats can navigate easily a channel difficult to negotiate with a rudder by a single boat. The two boats move together by the power on the power boat. In addition to this couple, from two to four other boats are towed astern on hawsers, and all are moved by the one power boat. Steam is the power now employed, but if internal combustion engines with suction gas producers were substituted greater economy would be secured and certain savings in expense of operation as compared with steam could be made. This is probably the cheapest means of moving traffic on a canal, and it has the very great advantage of enabling the fleet to navigate anywhere under its own power. In practice fleets of this kind under their own power travel from Buffalo through the Erie Canal to New York harbor, and thence through Long Island Sound to New Haven, Connecticut, or through connecting waters to the Delaware and Chesapeake Bays, and could travel any waters except the open ocean or the Great Lakes, where the risk of storms would be too great.

Size and Equipment of Locks

The size of the lock chambers and the depth of water on the mitre sills will depend on the width of the boats to be passed and their maximum draft loaded. If the boats are not too large, and there is plenty or water for locking purposes, it is probably better to build the locks to pass two boats simultaneously than to pass them singly. If they are to pass in pairs the locks should be arranged so that they will lie in the chamber one behind the other. If desirable, the chamber can be divided in the middle with gates, so that if only one boat is to pass the entire lock need not be filled, and water will be economized. This arrangement is especially desirable if boats are to be operated in pairs as described above, as it will render it unnecessary to disconnect them and time will be saved.

It is difficult to improve on the arrangement of the lock gates that has been in use many years. The material of construction may vary, but scarcely the arrangement, and the operation is a simple problem in the application of power.

There is greater range for variation in the facilities for controlling the water in filling and emptying the lock. The water should not be either put in or taken out largely at a single point, as this creates currents in the chamber that make it difficult to control the boats while filling and emptying. The bye-passes should be so arranged that the water can be introduced to and withdrawn from the chamber at several points along both sides simultaneously, then it can be filled or emptied with the greatest rapidity without danger to the boats or the gates.

As the controlling valves are at all times, except when being repaired, under water and out of sight, they should be of the simplest design and most rugged construction possible, and must be either designed to be easily and rapidly removed for repairs or provision must be made for the easy construction of cofferdams to permit the repairs, as these are the portions of locks that require the greatest attention and the most repairs. Cast iron is probably the best material for use in these parts. It is sufficiently strong and is cheap and admits of being readily cast into interchangeable parts. It resists the corrosive action of the water sufficiently long, because these parts are worn out by the action of sand and other solids carried by the water long before they are damaged seriously by corrosion. The various copper alloys are equally adaptable for the purpose, but their expense is hardly warranted, as they would wear out equally as fast as the cast iron, and the expense of repairs would be much heavier.

River Improvements Already Undertaken in the United States

The most ambitious project of river improvement for navigation undertaken in the United States, and probably in the world, is, of course, the improvement of the thousand or more miles of the Mississippi River. This has been under way for several generations, and is still far from being completed. Neither can the work actually completed be considered entirely successful. The Mississippi is a stream with a very small slope to its bottom; and yet, by reason of the large volume of water it carries, the current is not slow. It carries at all times a large volume of solid matter which it deposits in the long reaches of the river where the velocity is reduced. The banks are high, of alluvial material that is easily eroded, permitting the stream at high water to change its course easily. The work of improvement has consisted almost entirely in works to prevent or reduce this erosion and to confine the current into a narrower channel so as to create a scouring velocity at points where the filling of the channel with silt created difficulties. Millions of dollars have been spent in this work, and yet a satisfactory navigable channel at all stages of water has not been secured. It seems hardly worth while to go into the details of the construction and placing of mattresses and so forth, as this has so often been described in the technical press.

Many millions of dollars have also been expended in the attempt to make a navigable depth of water in the Ohio River from Pittsburg, Pa., to Cairo, Ill., where it joins the Mississippi. Here the problem is different, the slope of the stream is greater and the volume of water very much less. There are rapids in the stream, as at Louisville, Ky., and in the reaches of the river between Cincinnati and Pittsburg, so that the work had to be differently planned and carried out than on the Mississippi. At Louisville a dam and lateral canal were constructed and a number of dams have been built in the river above Cincinnati to secure the depth necessary for navigation. The principal traffic on the Ohio River is coal from Western Pennsylvania and Eastern Ohio, which is floated down the river on immense fleets of barges and reaches market at all points along the Ohio and Mississippi rivers as far as New Orleans. The tonnage carried, however, scarcely warrants the expense of the improvements up to this time.

A number of streams flowing into the Ohio River have also been improved to some extent, but the work has not been so important.

The problem of river improvement in the United States is the most colossal that has ever been given serious consideration, and the money required for the work staggers the imagination. Not less than 30 rivers and systems ten miles and more in length discharge into the Atlantic Ocean, and these have an aggregate mileage of about 4,765 miles. At least twenty-one rivers and systems of ten miles in length and over, exclusive of the great Mississippi River system, discharge into the Gulf of Mexico, aggregating a mileage of 5,235 miles, and the Mississippi River system alone, draining as it does fully half the area of the United States, has an aggregate mileage of about 13,017 miles, making a grand total of the rivers and systems, excluding those flowing into the Great Lakes and the Pacific Ocean, of 23,017 miles. When it is remembered that a comparatively small portion of this mileage will permit of continuous navigation by vessels drawing even as little as 5 feet of water some inkling of the magnitude of the work of improvement can be obtained.

Several hundred projects looking to the improvement of disconnected portions of this vast mileage have been undertaken by the Federal Government and, in spots, a great improvement has been made. It is only within a very few years, however, that any attempt has been made to correlate these improvements so that they will mutually support and extend each other so as to make the improved streams valuable as highways for commerce.

It is not worth while to even attempt to catalogue the names of these projects that have been undertaken or are being carried on. Anybody curious in this direction can consult the River and Harbor Bill annually since it took its permanent place on the calendar of Congress, and there he will find all the projects listed, together with the amount that has been appropriated for carrying them out.

In addition to these river improvements proper some little work has been done in the direction of building canals by the Federal Government and a greater mileage, though not of as large construction, has been undertaken by the various States at their own expense.

Omitting those artificial channels between arms of the ocean that have been constructed by the Federal Government, the most important is the canalization of the St. Mary's River, connecting Lake Superior and Lake Huron. This improved waterway passes more tonnage annually than the Suez Canal, and is probably the most important artificial waterway in the world, so far as tonnage is concerned.

The Illinois and Mississippi Canal, connecting the Illinois River and the Mississippi, was also built by the Federal Government, and it, with the Illinois and Michigan Canal, built by the State of Illinois, make a continuous waterway from Lake Michigan to the Mississippi River. This canal, however, has not grown to a position of importance as a highway for commerce. Out of all the commerce originating in the very productive territory through which it passes it carried in 1910 only the paltry tonnage of 244,635 short tons, and more than half of this was tonnage of the government.

Of the canals built or being built by far the most important is the Erie Canal now being enlarged by the State of New York so as to permit the passage of barges carrying 1,000 tons. This canal extends from Buffalo to Albany, and, together with the Hudson River, makes a continuous waterway from the Great Lakes to the Atlantic Ocean.

In addition to the States of Illinois and New York already mentioned, Ohio is making some expenditures for improving its old and practically abandoned canals. During the early part of the nineteenth century, when canal building was popular, Ohio built two separate canals, connecting Lake Erie with the Ohio River. These canals were small and would only permit the passage of boats of about ten feet beam and drawing about five feet when loaded. An attempt is being made to rehabilitate these canals, but unfortunately, instead of at the same time enlarging them to permit the passage of boats of economical size, they are being rebuilt on practically the same old lines, and no effort is being made to increase their capacity.

None of the other States, or, for that matter, no corporations, are doing any work toward building canals or improving navigation facilities, and out of the several thousand miles of improved waterways and canals, built by the several States in the early part of and operated up to the middle years of the nineteenth century, scarcely 400 miles, exclusive of the Erie Canal, are in operative condition.

Dimensions to Be Given to Maritime Canals

With the rapid increase in size of ocean liners that has taken place within a very few years it is difficult to foresee just what depth and width should be given to maritime canals that are to be used by the future ocean carrier. However, there are a few general principles that will have a strong effect on the design of ships and which in turn will dictate the economic size of the canals through which they are to navigate. Canals will probably not be built for the use of the large ocean greyhounds, as they will always be used for the fast service, and the difficulty and delay incidental to the navigation of the comparatively narrow channel of a canal will make the service through them not only slow but unprofitable. Their ports will always be on large deep bays and arms of the ocean, which, though they will be improved waterways, will not in the strict sense be called canals.

The depth, and this has more controlling effect than any other dimension, of any canal will be dictated by the traffic that is expected to use it, and this in turn by the depth or draft of the vessels. The economic draft of the freighter of the future will be controlled by the depth of the channels in the ports at which it calls. The economic freighter is the one of such a size that it can go to any of the principal ports of the world, and can be used in any traffic in search of freight and can enter any of the principal ports of the world. A great number of these ports have not any great depth of channel, and it will be many years before they will be improved, and yet they are, and will for many years, be ports from which great quantities of traffic are handled. It is probable that 26 feet is the maximum draft of vessels that can enter the majority of such ports, and unless the canal be designed for the purpose of handling some particular traffic, it should be designed for a draft of vessel of about 26 feet. The draft being established, the other dimensions follow naturally and the width of the locks of the canal will be designed accordingly. Turning basins and passing points will be made to accommodate the width of vessel, the length of vessel that is indicated by the depth and curves will be designed from the same data. Vessels of this type while navigating the canal under their own power can hardly expect to make a greater speed than about two miles an hour. It is probable, however, that with an efficient means of towing the vessels from the shore a higher speed, possibly even as much as four miles per hour may be attained, but this will be only where the channel is wide enough to permit this displaced water to flow past the moving vessel with a velocity sufficiently slow to avoid running the vessel aground by the stern.

From the limitations imposed by the lack of great depth in most of the harbors of the world the "tramp" steamer will not for many years attain the size of the leviathan used in the transatlantic trade.

New French Line Steamship France

The new French liner *France,* which recently made her maiden voyage from Havre to New York, is not only the largest and speediest French merchantman, but her accommodations are more luxurious and tasteful than in all previous boats of this line. Both engines and hull have been built at the Atlantic Works, St. Nazaire. Her keel was laid April 20, 1909; she was launched Sept. 20, 1910, and left the builders' yard April 3, 1912, for her trials. She is of the following dimensions:

Length over all	715 feet 3 inches.
Length between perpendiculars	685 feet 2 inches.
Breadth	75 feet 3 inches.
Depth to the main deck "D"	52 feet 10 inches.
Depth to the upper deck "A"	78 feet 9 inches.
Draft, loaded	29 feet 6 inches.

THE FRANCE, THE LARGEST AND SPEEDIEST FRENCH MERCHANT VESSEL

Gross tonnage	23,000
Displacement	28,000
Cargo capacity	6,000
Shaft-horsepower	45,000
Designed service speed	23.5
Best speed on official trials	25.9

The hull is built of Siemens-Martin steel, the upper works excepted, which are made of high-tensile steel. The keel consists of three plates 2⅝ inches thick, riveted by hydraulic power. A double bottom of 2,500 tons water capacity, extending for nearly the whole length of the ship, is divided into sixteen watertight compartments. From stem to stern the vessel itself is divided into thirteen watertight compartments by transverse bulkheads, which are pierced by twenty watertight doors, operated either by hydraulic power or by hand, according to Stone Lloyd's patent. The captain, from the navigating bridge, may close or open separately all the doors or close them all at once. A loud bell is always put into action before the doors are closed from the bridge, and if anyone is locked into a compartment he may open the door by hand, which will close again after his escape. The necessary water for operating the doors is maintained in two accumulators under a pressure of 550 pounds. A Weir pump keeps the water in the accumulators under the normal pressure. In case water enters any compartment it may be discharged outside by seven powerful steam pumps, having a total capacity of 2,500 tons of water per hour.

The hull is further divided by eight steel decks, which from the bottom are named H, G, F. E, D—main deck—C, B and A at the top.

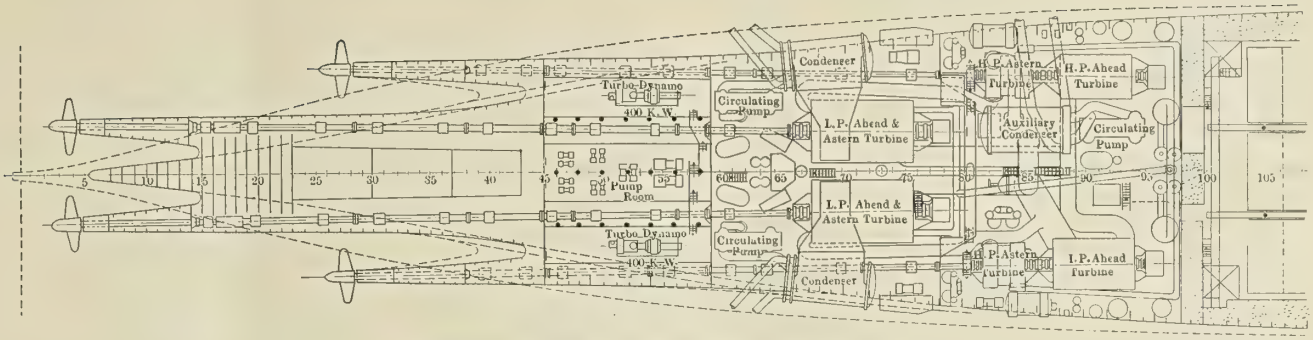
Above the "A" deck there is a deck house, containing the captain's apartments, the chart and pilot house and the navigating bridge, which is about 52 feet 6 inches above the load waterline.

On the "A" deck there are a few lifeboats, all of the thermotank ventilators, the dog kennel, the skylights opening to the first and second class accommodations and the engine rooms.

On the "B" deck, or boat deck, are located in large deck houses the officers' quarters, the children's room, the gymnasium, the printing office, library, bookseller's shop, wireless office, telephone office; then about amidships are the first class social hall, the monumental entrance to the first class accommodations, and towards the stern are the *"salon mixte,"* the smoking room and the open café. All these different rooms are conected by a splendid gallery.

Forward on the "C" deck there is an observation room, and on both sides for about 90 feet in length there are thick panels of glass, which give a good shelter for the passengers and enable them to have a good view over the sea in spite of bad weather. This deck is used as a promenade deck by the first class passengers. It is devoted to the "apartments de luxe" and to the first class cabins. Near the main staircase there is the flower shop. Aft is the entrance to the second class accommodations, and the after end of this deck is at the disposal of the second class passengers. Forward and aft are the winches, capstans, etc., for maneuvering purposes as well as for handling the cargo.

Both ends of the "D" deck, or main deck, are reserved for the crew, third class and steerage passengers. Amidships it is divided into numerous first and second class staterooms, to-



MACHINERY SPACE OF THE FRANCE (*From Le Yacht*).

gether with the postoffice, ladies' hair dressing room, information office; aft, there is the second class smoking room.

The "E" deck—the first 'tween deck—is almost entirely devoted to the first and second class passenger accommodations; forward there are the crew's quarters, together with third class staterooms, also the hospital and infirmary.

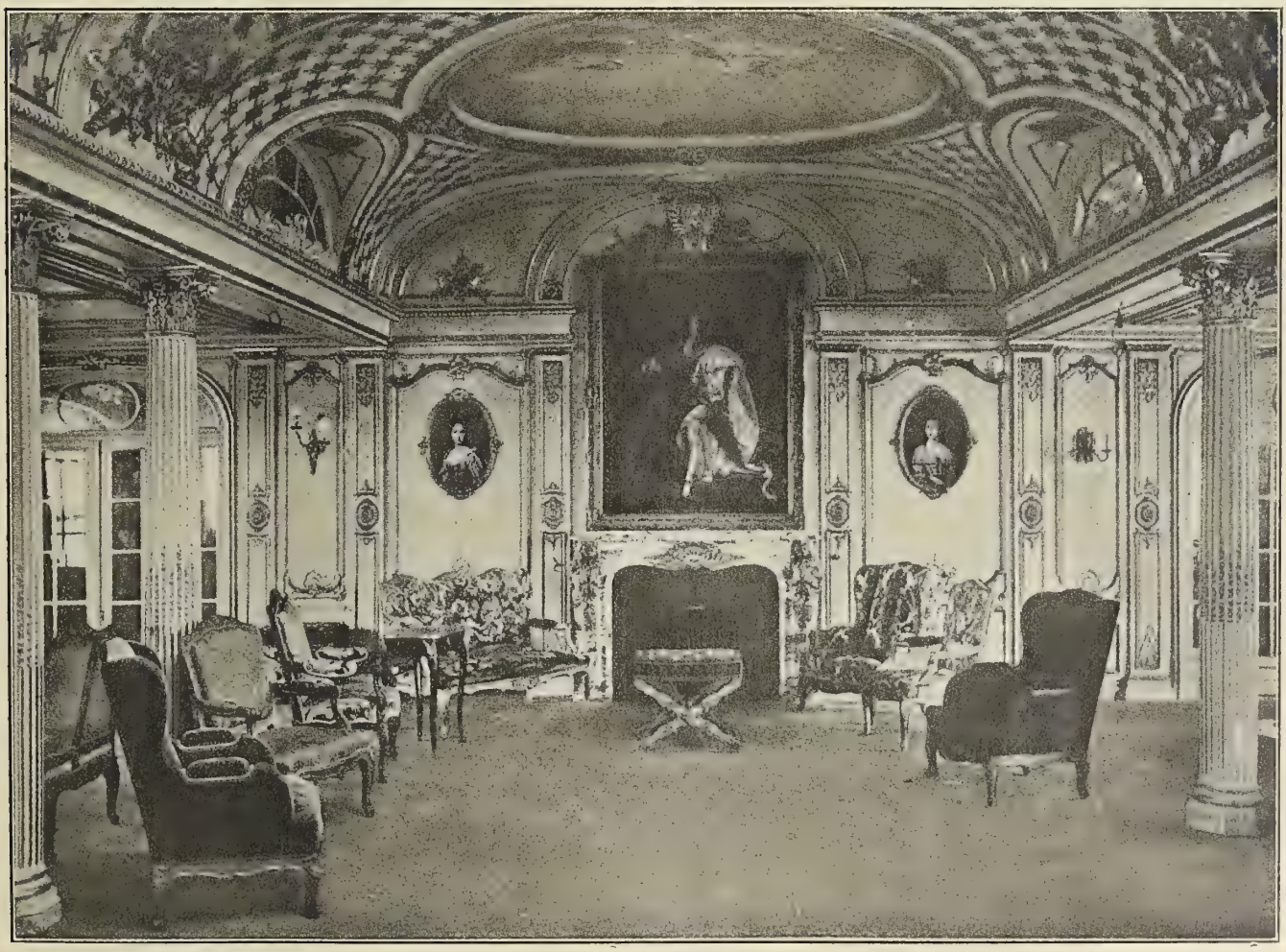
Forward on the "F" deck are the crew and steerage passengers' quarters. Amidships is the first class dining room, extending two decks in height; abaft of the same is the galley and its accessories, then comes the engineers' quarters alongside the engine room casings; aft are the second class dining room and staterooms.

The "G" deck, or third 'tween deck, is devoted, forward and aft, to the steerage passengers, and in the central part of the ship to the firemen, stewards and stewardesses.

The fourth 'tween deck, or "H" deck, is occupied chiefly by cargo and bunker space; there are also large storerooms, refrigerating rooms for meat, fish, vegetables, game, etc., passenger luggage rooms, etc. Down below, on top of the water ballast tanks, are the boiler, engine and dynamo rooms, the bunkers and cargo holds.

Referring to the accommodations, all the social halls are in connection with a large gallery. Neither sculpture nor golden decorations have been used there; the panels are made of thin wooden lattice work. Evergreens and flowers are in profusion, and the whole arrangement very much resembles a winter garden. It is lighted by numerous electric lamps and large bow-windows.

The first class drawing room is of the finest Louis XIV. period. Owing to its dimensions, selected with care, it gives an ideal relief to the furniture. All of the decorations are carried out in pleasing harmony. Excellent pictures are used in decorating the ceiling and the panels. Among others there are paintings of Louis XIV., a Return from Hunting at



FIRST CLASS DRAWING ROOM ON THE FRANCE. DECORATIONS OF THE FINEST LOUIS XIV PERIOD

Vendôme Castle, the portraits of Margaret of Burgundy, Miss de la Vallière, Duchess of Aoste, Anna of Scotland, etc.

The *"salon mixte"* is of the "Renaissance" period; it is to be used both as a writing and music room. The smoking room is of a fancy Turkish style, and with its white marble fountain has a very unique appearance. The coffee house is of carved oak; the open café of lattice work, resembling a garden. The children's dining room is paneled with carved wood, with several medallions representing child scenes from La Fontaine's stories.

The entrance to the first class accommodations is a monumental one. First, there is a bronze statue of France, set in a

CARVED WOOD PANELS IN THE "APARTMENTS DE GRAND LUXE"
MARBLE FOUNTAIN IN THE MOORISH SMOKING ROOM
STATUE OF FRANCE, BY NELSON, AT THE FIRST CLASS ENTRANCE

recess of red marble. A dome of forged iron with stained glass is placed above the staircase. The first class dining room is situated on the "F" deck; the panels are decorated with a frieze representing a hunting scene. A monumental staircase of forged iron connects the two floors of this room. On the panel of the staircase is a painting showing a scene of the Versailles gardens at the time of Louis XIV. This dining room, extending the whole width of the ship and two decks in height, is large enough to accommodate 375 persons at the same time; all tables arranged for from two to seven persons.

There are four "apartments de grand luxe," each consisting of a bedroom, a drawing room, a dining room and a bath room. One is of the Louis XIV. period, one of the Empire, and others of the Directoire style. The panels are of carved wood, marvelous pieces of cabinet work, indicative of the sumptuousness of a prince's palace or castle.

The first class staterooms have been erected according to the drawings obtained in a concourse established by the owners. Fifty-three staterooms for two passengers have been built according to the drawings of Mr. Truck; the panels are of lemon wood, with a frieze of fibro-cement, and they are of very graceful appearance. Fifty-four other two-passenger staterooms have been built according to Mr. Laffilée's designs; they are of fibro-cement panels with "bageuttes" of lemon wood. Sixty staterooms for one passenger have been decorated by Mr. Adams in the English modern style; the panels are of olive wood. These cabins are designed for comfort, and are so arranged that they can be transformed into two-passenger staterooms by especially designed doors. There are sixty staterooms which have been designed by the "Atlantic Works"; they are for four, two or three passengers, the panels being of lemon and rose woods. All of the "apartments de luxe" are equipped with telephones.

The accommodations for the second class passengers are, of course, not so elaborate, but they offer the same comfort. There are 126 second class staterooms, with four or six berths; the panels are of mahogany wood, as is also the furniture.

The heating and ventilation of all apartments is electrically operated, and each passenger may regulate at will the temperature of his own stateroom. All dining rooms, smoking rooms, etc., are automatically heated and ventilated. When the temperature is at a certain minimum or maximum the fans are automatically set at work, either for cooling or heating the air delivered into the accommodations.

There are two electric elevators at the disposal of the first class passengers, going through four decks; a single elevator, running through three decks, is to be used by the second class passengers. Four hundred electric clocks are distributed throughout the ship. There is one clock in each first class stateroom. They are all regulated by the chief officer from the navigating bridge.

Below the lower deck, as already stated, nearly the full length of the ship is occupied by the machinery space, viz.: 279 feet by the boiler rooms and 148 feet by the engine rooms.

There are twenty cylindrical marine boilers, either single or double-ended, made of semi-hard steel, designed to work under a pressure of 200 pounds per square inch. There are four boiler rooms, each having its own funnel, extending 112 feet above the grate bars, of elliptical section with diameters 13 feet 6 inches and 17 feet 5 inches. The total number of furnaces is 120; the grate surface aggregating 2,600 square feet and the heating surface to 101,100 square feet (ratio 1/38). The boilers are operated by the Howden forced draft system, which is maintained by electrically-driven fans. The ship carries 5,000 tons of coal in her bunkers for a single trip.

The four propellers are driven by four lines of shafting, each transmitting about the same power. The main turbines consist of one high-pressure, one intermediate-pressure and two low-pressure ahead turbines, and two high-pressure and two low-pressure astern turbines. The engine room is divided into three main compartments, the first two containing the main turbines. In the first is located the high-pressure and medium-pressure turbines driving the wing shafts and the auxiliaries and the auxiliary condenser. In the forward part of the engine room is the starting platform, connected with the ahead and astern turbines, and from which all turbines may be controlled. The starting platform is connected by telemotors, telephones and telegraphs with the navigating bridge. In the second engine room are the low-pressure turbines and the main condensers, together with their auxiliaries. In the forward part of this room is a small starting platform acting on the inner shafts only when used for maneuvering purposes. Under full load, at 240 revolutions per minute, the shaft-horsepower developed was over 45,000, and the speed obtained 25.9 knots.

Turbine casings are of cast iron, the rotors of fluid compressed steel, as well as the disks; they have been machined

out of ingots. The blading has been made according to Parsons' latest design, with the usual method of binding. The shafts are made from steel ingots. The bearings work under forced lubrication. The high-pressure turbine alone weighs 120 tons, the medium-pressure 115 tons, each of the low-pressure turbines 250 tons and the shafting about 150 tons.

The four bronze propellers of the four-bladed type are 13 feet 2 inches in diameter. The two main condensers have a surface if 43,000 square feet.

The auxiliaries of the main engines are in duplicate in order to meet the needs of such powerful machinery even if one of the compartments should be flooded.

The electric plant consists of four 220-volt dynamos operated by steam turbines, and supplies current for about 6,000 lamps and for the forced draft and ventilating fans, and also for the electric elevators, boat winches, cargo winches, capstans, etc. The refrigerating plant, consisting of two machines, has been so designed as to maintain a temperature of 5 degrees C. in the cold chambers.

One of the most interesting parts of the ship is the chart room and the navigating bridge. It may be called the brains of the liner. In a large bridge house are located the compass, the German hydro-electric steering gear, the Stone Lloyd's maneuvering gear for the ship's watertight doors, and a plan giving the exact position of the twenty doors, showing whether they are closed or open. Owing to the long distance between the bridge and the starting platform in the engine rooms, special telegraphs have been used: First, ordinary telegraphs of large size and in duplicate, then special telegraphs. When an order is given from the bridge an electric lamp is lighted, and then cut off when the engineer has answered the order. This telegraph, which is practically like that used in naval vessels, is in duplicate, both for the main engines as well as for the low-pressure turbines driving the inner shafts, and is used for maneuvering purposes. A similar telegraph is used for transmitting orders to the after navigating bridge.

There are twenty lifeboats, 30 feet by 8 feet 3 inches, each with a capacity for fifty-two persons, besides a whale boat and a dinghy.

The crew consists of sixty deck hands, 260 engine hands and 275 stewards, pursers, stewardesses, etc. The accommodations have been designed for 550 first, 450 second, 250 third and 800 steerage passengers.

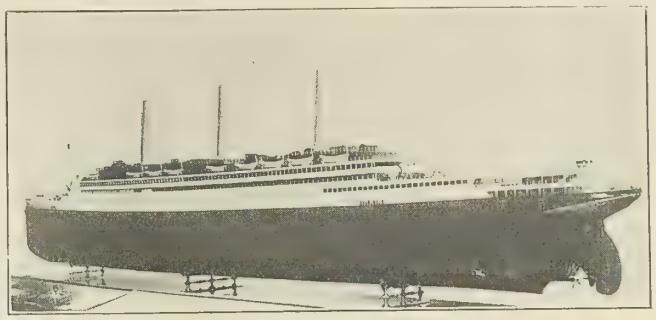
The French Trans-Atlantic Company has just ordered another still larger liner, 821 feet in length, to be built in the same yard, but the order is subject to improvements to be carried out in St. Nazaire harbor, so as to enable the launching and drydocking of this new ship. At present the St. Nazaire drydock could not take in a ship of that length, but this matter will shortly be settled and the building started.

It is also practically certain that further improvements will be made in the river Loire, where a channel 2,600 feet in width, extending several miles in length, will be dredged to a depth of 45 feet, therefore enabling large ships to enter or leave at any time without the necessity of locks. The matter is pending before the Public Works for approval.

The United States battleship *Texas* was launched May 18 by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. With all stores aboard the vessel will displace 28,367 tons. The dimensions are 573 feet length and 95 feet 2½ inches beam. The draft will be 28 feet 6 inches, and the speed 21 knots. This will be the first ship in the world to carry 14-inch guns, of which there will be ten, in addition to which there will be twenty-one 5-inch rifles. The vessel will be propelled by twin-screw triple-expansion engines of the old type, developing 27,000 horsepower. The fourteen watertube boilers will be fitted for burning either coal or oil.

Launch of the Imperator

The Hamburg-American Line steamship *Imperator* of 50,000 tons was launched May 22 at the yards of the Vulcan Shipbuilding Company, Hamburg. This vessel is the largest ship afloat. Her length is about 900 feet and her beam 96



MODEL OF THE IMPERATOR

feet. Her engines are designed to develop 70,000 horsepower, giving the vessel an average speed of 22½ knots. The photograph shown herewith is a view of a 20-foot model of this ship.

Important Notice

Engineers, steam fitters, contractors and users of valves and fittings are notified by members of the Manufacturers' Standardization Committee that it would be inadvisable to specify or order flanged fittings to the so-called 1912 United States standard for standard weight and extra heavy flanges and flanged fittings as adopted by the National Association of Master Steam and Hot Water Fitters, because this standard has not been accepted as final by the manufacturers of flanged fittings and valves, and will not be accepted until certain necessary revisions have been made to suit the practical requirements of all concerned. Although it is not generally understood, there has been for some time a manufacturers' standard for flanges and flanged fittings which has been adopted by the leading manufacturers. This standard is the result of many years of experience on the part of the manufacturers, engineers and large consumers. Therefore, any standard which would replace the existing one should necessarily make as few changes as possible and then only where experience has proved the change absolutely necessary. This committee has already compiled a proposed standard bearing in mind all the considerations above mentioned. Therefore it is deemed advisable to maintain for the present the old practice until a universal standard can be agreed upon.

At a public meeting, May 9, under the auspices of the American Museum of Safety, New York, Mr. Axel Welin, of London, read a paper on boat installations and other life-saving devices for safety at sea. The paper was devoted almost entirely to a description of the Welin davit and the methods of stowing lifeboats and the tackle for handling boats, showing the development from crude methods to modern scientific apparatus.

Orders were received at the United States Navy Department on May 18 for the scout cruiser *Birmingham* to steam to the regions where dangerous ice floes and ice bergs menace North Atlantic travel and remain there on patrol until further orders. Wireless reports will be received from this ship twice a day at the Navy Department, and they will be transmitted through the Hydrographic Office to the steamship companies using this route.

Old American Coasting and Sound Steamers—Part III

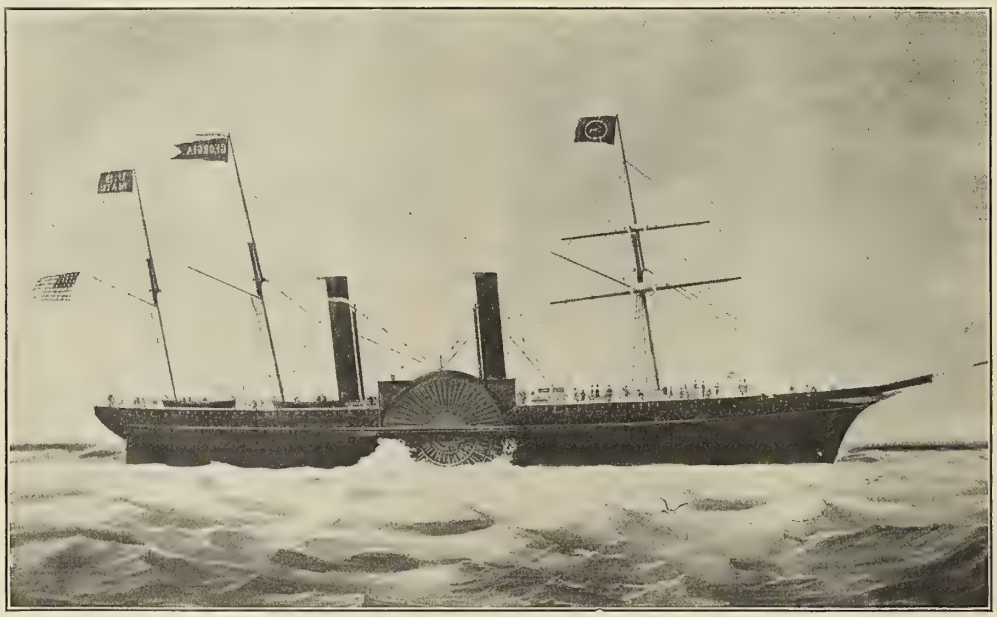
BY FRANCIS B. C. BRADLEE

The first line of Southern steamers from Boston was the Boston & Philadelphia Steamship Company, which started in 1852 with two steamers called the *Palmetto* and *City of New York*. The Merchants & Miners' Transportation Company, running to Baltimore, began operations in 1854 with two wooden side-wheel steamers built in Baltimore, the *Joseph Whitney* and the *William Jenkins*. The former was 208 feet by 33 feet by 17 feet, with a beam engine, cylinder 52 inches in diameter by 11 feet stroke; the latter measured 205 feet by 31 feet by 11 feet, and also had a beam engine with a 56-inch cylinder 9 feet stroke. These two boats were supplemented in 1859 by two others of the same type, but slightly larger and constructed of iron, being among the first American iron seagoing steamers. They were the *Benjamin de Ford* and *S. R. Spaulding*, and were built by Harlan & Hollingsworth, at Wilmington, Del. They were used as transports during the Civil War, and afterwards were sold and re-named *San Salvador* and *San Jacinto*, and ran for many years from New York to Savannah.

After the war the Merchants & Miners' Line added many screw steamers to its fleet, among them the *George Appold*, built of wood at Philadelphia in 1864, 223 feet by 35 feet by 24 feet, with a direct-acting engine having a 56-inch cylinder by 42-inch stroke, and the *William Lawrence*, built of iron in 1869 by the Atlantic Works at East Boston (she is believed to be the first iron steamer of large size constructed in Boston), 230 feet by 35 feet by 28 feet. To-day this line has one of the largest fleets in the United States. The Boston & Philadelphia Steamship Company was absorbed by it a few years ago.

The "outside" line between Boston and New York (Metropolitan Steamship Company) was begun in 1866 with three wooden propeller steamers that had previously been employed on Long Island Sound. These were the *Glaucus*, *Nereus* and *Neptune*, all alike, measuring 240 feet by 40 feet by 17 feet, and having simple condensing engines, each with two cylinders 44 inches in diameter by 36 inches stroke. This line has always devoted most of its attention to freight, although in the last two or three years they have run in the summer months the fast turbine passenger steamers *Harvard* and *Yale*.

Previous to the war of the Rebellion the water transportation business between Savannah and Boston was by sailing vessels, regular lines of packets, for freighting purposes mainly, running between this and other Southern ports and Boston. In 1869 F. W. Nickerson & Company, of Boston, established a steamship line on this route. Their first vessel, the *Oriental*, was an iron screw steamer of 800 tons burden. The *Oriental* made the round trip in twenty days. The *Alhambra*, a steamer of 700 tons, was added. Finally, in 1881, the Boston & Savannah Steamship Company was organized, and they bought from the Ocean Steamship Company two iron screw steamers, the *Gate City* and *City of Columbus* (first of the name). The former was 2,000 tons gross, 254 feet by 38 feet by 15 feet, with inverted two-cylinder compound engines, the hull and machinery being constructed by John Roach & Sons, at Chester, Pa., in 1878. The *City of Columbus* was wrecked with great loss of life near Gay Head, Martha's Vineyard, in January, 1884, and soon after this the line was bought out by the Ocean Steamship Company, who continue it to this day, adding one fine steamer after another to their fleet.



STEAMER GEORGIA, 1849. NEW YORK AND CHAGRES (CAL.) ROUTE. (FROM A LITHOGRAPH IN THE AUTHOR'S POSSESSION)

The first coastwise steamer worthy of the name hailing from New York was the *Robert Fulton*. Morrison, in his "History of American Steam Navigation," says: "She was built in 1819 by Henry Eckford for Dunham & Company to run between New York and New Orleans, stopping on the way at Charleston and Havana.

"The *Robert Fulton* was 700 tons burden, 158 feet long, 33 feet beam, 15 feet depth of hold; the paddle-wheels were 24 feet in diameter. The motive power consisted of a 'cross-head' engine built by the Allaire Works, and having a cylinder 44 inches in diameter by 5 feet stroke. The connecting rods operated cog-wheel cranks on the water-wheel shafts, gearing

into cog-wheels on a flywheel shaft, the wheels running on each side of the cylinder. The boilers were of copper, placed forward of the engine, with two smoke chimneys placed side by side in front of the gallows frame."

The *Robert Fulton* may be considered as one of the world's earliest seagoing steamers. She ran regularly between New York and New Orleans, via Charleston and Havana, from

ATLANTIC COAST STEAMER QUAKER CITY, 1854. (FROM A LITHOGRAPH IN THE AUTHOR'S POSSESSION)

April, 1820 (the date of her first voyage), until 1825, when, the financial results obtained becoming indifferent, she was sold to the Brazilian Government and her machinery removed. Her usual time was as follows: New York to Charleston, 4 days; Charleston to Havana, 4 days; Havana to New Orleans, 3 days.

After the *Robert Fulton* there were no Southern coastwise steamers until 1832, when a concern called the Southern Steam Packet Company was organized in New York, and ran several small steamboats called the *David Brown, William Gibbons, Home,* etc., to Charleston, S. C. These boats were built on the plan of the Long Island Sound steamers, and were unfitted to meet very heavy weather, the *William Gibbons* and the *Home* being lost near Cape Hatteras with great loss of life. These disasters threw a damper over "deep-water" steam navigation, so that for several years there were no coastwise steamers running out of New York.

In 1845, Spofford, Tileston & Company, of New York, merchants largely engaged in the Southern trade, had built by William H. Brown, of New York, a steamer called the *Southerner,* a wooden paddle-wheeler, to ply between New York and Charleston. She was about 950 tons, 191 feet long, 30 feet beam and 14 feet depth of hold, having a side lever engine with one cylinder 67 inches in diameter by 8 feet stroke. The *Southerner* was followed by several steamers of slightly increased dimensions called the *Marion, Northerner* and *James Adger.*

Prior to the breaking out of the Civil War the best-known and largest of the Charleston line steamers was the wooden side-wheeler *Nashville,* built by William Collyer at New York in 1853. She was considered at that time the fastest coastwise steamer, and made one or more trips between New York and Liverpool on the Collins Line in 1855. This steamer measured 1,220 tons gross, 215 feet by 34 feet by 21 feet, with a side-lever engine having one cylinder 86 inches in diameter by 8 feet stroke. The *Nashville* was seized at Charleston by the Confederate authorities soon after the fall of Fort Sumter.

She then remained idle until it was decided that she should take Messrs. Mason and Slidell on the first stage of their journey to Europe. When this intention was revoked, she was sent out under the command of Lieut. Robert B. Pegram, to make what might be called "a voyage of announcement" of a Confederate man-of-war to England. Her armament consisted of only two 12-pounder brass guns. On Nov. 19, 1861, when nearing the English channel the *Nashville* captured and burnt the ship *Harvey Birch,* of New York, homeward bound from Havre. The news of this event created great excitement in the North. After a stay of some length in England the *Nashville* returned to Beaufort, N. C. She then made one or two very successful blockade running trips, and was refitting in the Ogechee River (Georgia) in February, 1863, for a second cruise to Europe when she grounded near Fort McAllister, and the next day was attacked and burnt by the United States monitor *Montauk.*

After the Civil War the New York & Charleston Steamship

NEW YORK AND CHARLESTON LINE STEAMER NASHVILLE, OF 1853. AFTERWARDS A CONFEDERATE PRIVATEER. (FROM A LITHOGRAPH IN THE AUTHOR'S COLLECTION)

Company operated three steamers called the *Champion, Manhattan* and *Charleston.* The former was an iron side-wheel boat (one of the early examples of American iron shipbuilding), built by Harlan & Hollingsworth in 1859 for Commodore Vanderbilt's line of steamers to the Isthmus. She was 1,850 tons gross, 242 feet by 35 feet by 26 feet, with two vertical beam engines, having cylinders 42 inches in diameter by 10 feet stroke; paddle-wheels 30 feet in diameter. The *Manhattan* and *Charleston* were wooden side-wheelers somewhat smaller than the *Champion.*

Steam communication between New York and Savannah

was begun in 1848 by the New York & Savannah Steamship Company, who ran for a short time two wooden paddle-wheelers called the *Cherokee* and *Tennessee*. They were about 1,250 tons each. The former was sold to the Law Line of Chagres and Havana packets, and burned at her dock at New York in 1853, and the latter was sold to the Pacific Mail Steamship Company and lost near San Francisco, also in 1853. After this various steamers ran to Savannah for shorter or longer periods, the best known of which was the wooden propeller *R. R. Cuyler*, built in 1859, 235 feet by 32 feet by 16½ feet, fitted with an inverted direct-acting engine having a cylinder 70 inches in diameter by 48 inches stroke.

After the Civil War, Livingston, Fox & Company, of New York, who owned four wooden side-wheelers, the *Rapidan, Raleigh, Albermarle* and *Hatteras*, all alike, each being 800 tons, 180 feet by 33 feet by 19 feet, with vertical beam engines, having a 44-inch cylinder by 11 feet stroke, engaged in the Savannah trade. An opposition line was run by Murray, Ferris & Company, with two small, box-like, "sawed off" wooden propellers, the *Leo* and *Cleopatra*. Both before and after the Civil War the Southern lines of steamers had, in proportion, a much larger passenger business than they do to-day, for in those early days the Southern railroads had not good reputations for rapidity or comfort, and after the war most of them were for some time in an extremely demoralized condition. About 1871 the various Savannah steamship interests were amalgamated into one company, now the well-known Ocean Steamship Company. They used the old boats for a while, and afterwards added such fine ships as the iron propellers *City of Macon*, first of the name (1877), *City of Augusta* (1880), etc.

Another well-known steamer of the early days that acquired quite a reputation for high speed was the *Quaker City*. She was built of wood by Vaughan & Lynn at Philadelphia in 1854, and was 1,428 tons gross, 240 feet by 36 feet by 21 feet, with one side-lever engine having a cylinder 88 inches diameter by 8 feet stroke. This vessel was employed in many and various trades, at first between Philadelphia and Charleston, then she was chartered by the Collins Line after the loss of the *Arctic* and *Pacific*, and made a number of voyages between Liverpool and New York. Just before the Civil War the *Quaker City* was running to Havana from New York; then she was bought by the United States Government and used as a man-of-war in the blockade of the Southern coast. After the war she was employed for a time between New York and Bremen on the North American Lloyds line, and in 1867 she was chartered to take a party of excursionists to the Holy Land and Europe. Mark Twain was one of the party, and the "Innocents Abroad" was partially written on board the *Quaker City*.

What was known as the "Law Line" of steamers between New York and Chagres (owned by Law, Roberts & Company), was started in 1849. This enterprise was given a great impetus by the discoverey of gold in California, from the fact that there was then no trans-continental railroad, and the route via the Isthmus was the shortest way of communication between the Eastern States and the Pacific Coast. They also had a contract amounting to $290,000 (£59,600) a year from the United States Government for the carriage of mails. When the grand rush for California took place the most exorbitant rates of passage were charged, at one time being as high as $600 (£123) first class and $300 (£62) steerage.

BOSTON-BALTIMORE STEAMER GEO. APPOLD, 1864. (FROM A LITHOGRAPH IN THE AUTHOR'S COLLECTION)

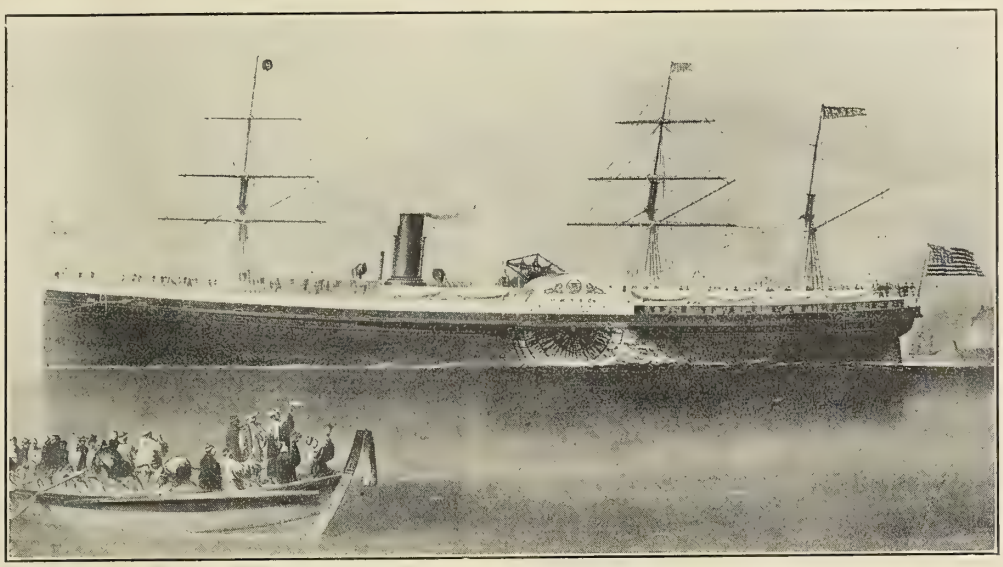
The first two vessels of the Law Line were the *Ohio* and *Georgia*, built of wood at New York in 1849 by J. Simonson and Smith & Dimon, respectively. The *Ohio* was 2,397 tons gross, 248 feet by 45½ feet by 24½ feet, the *Georgia* being 2,695 tons gross, 255 feet by 49 feet by 25½ feet. The engines of both steamers were exactly alike, of the side-lever type, constructed by T. F. Secor & Company, New York. Each engine had two cylinders, each 90 inches in diameter by 8 feet stroke. There were four iron boilers, two forward and two abaft the engines. The average speed of these vessels in good weather was 12 knots.

The largest and best known of the Law Line boats was the *Illinois*, constructed in 1851 by Smith & Dimon. She measured 267 feet by 40 feet by 31 feet, and her machinery was of a then novel type to American engineers, and one that somehow never recommended itself to them. It was built by the Allaire Works, New York, and consisted of two oscillating cylinders, each 85 inches in diameter by 9 feet stroke; diameter of the paddle-wheels 33½ feet. The *Illinois* had four iron return tubular boilers and her maximum speed was 13½ knots. On one occasion she ran from Chagres to New York, 1,980 miles, in 6 days 16 hours, being an average of nearly 12½ knots during the whole voyage. The *Illinois* was broken up at New York in 1862. One clause in the United States mail contract with the Law Line read that their vessels should be commanded by lieutenants in the United States navy, and it is

interesting to note that the captain of the *Georgia* was for several years David D. Porter, afterwards admiral of the United States navy.

These steamers connected on the Pacific side with the ships of the Pacific Mail Steamship Company (then just started), consisting of the *Golden Gate, John L. Stevens, Tennessee, Oregon, California,* etc., all wooden side-wheelers. The *Golden Gate* and *John L. Stevens* were the largest of these vessels, the former was 2,030 tons gross, 265 feet by 40 feet by 22 feet; the latter being 2,450 tons gross, 280 feet by 40 feet by 26 feet. The machinery for both steamers was exactly alike, each set consisting of two oscillating cylinders 85 inches in diameter by 9 feet stroke.

The Pacific Mail Company had a hard time at first. Their steamers found not ing ready to receive them on the Pacific Coast. The company was compelled to construct large work-



PACIFIC MAIL STEAMSHIP COMPANY'S GREAT REPUBLIC (1866), THE LARGEST WOODEN OCEAN STEAMER EVER BUILT

shops and foundries for their repair, and had also to build their own dry dock, that of the Government at Mare Island not being ready until 1854.

For a large portion of the early time the company had to pay $30 (£6 5s.) per ton for coal, and once as high as $50 (£10 8s. 4d.). During the late 50's there was great competition on the New York and Chagres line, Commodore Vanderbilt running several of his steamers, the *Champion, North Star, Northern Light, Ariel,* etc., in opposition to the Law or United States Mail Line. At this period also took place one of the most awful maritime disasters that ever occurred, and that was the loss of the *Central America* ex *Geo. Law,* belonging to the Law Line. She foundered during a severe gale, Sept. 12, 1857, while on her way to New York via Havana. About 423 persons were lost, and the general opinion at the time was that the *Central America* was not in a seaworthy condition.

Later on the Pacific Mail Company gained control of the traffic on the Atlantic as well as the Pacific side. In the late 60's and early 70's the following steamers ran on the Atlantic side: *Henry Chauncey, Montana, Arizona, Atlantic, Baltic* (ex-Collins liners), etc., and on the Pacific line the *Constitution, Golden City, Colorado, Golden Age* (formerly built to run from New York to Australia), etc. All these ships were large wooden side-wheelers, most of them being over 3,000 tons and over 300 feet long, and all except the *Atlantic* and *Baltic* had vertical beam engines of large power. It is said that when these large side-wheelers were heavily loaded at the beginning of their voyage their wheels were so deeply immersed that the ship would not make over 8 knots.

The first line of direct steamers to New Orleans was started by Livingston, Crocheron & Co. in 1854, with the wooden paddle-wheelers *Black Warrior* and *Cahawba.* They were built in New York, 225 feet long, with the usual vertical beam engines. The *Black Warrior* went ashore on Rockaway Bar, L. I., in February, 1859, and became a total loss. To take her place the company built more ships of the same type but larger—the *De Soto* and *Bienville.* They were in the Government service during the Civil War. After the war the best-known New Orleans line of steamers was what was called the Star Line, running the *Evening Star, Morning Star, Guiding Star* and *Rising Star,* large wooden side-wheelers about 270 feet long, with beam engines. One curious fact about these vessels was that, with the exception of the *Rising Star,* their engines had all been in use previously in steamers on the Great Lakes. The *Evening Star* foundered in a cyclone off Tybee Island with great loss of life Oct. 3, 1866.

The New York & Virginia Steamship Company was the predecessor of the present Old Dominion Line running to Norfolk and Richmond, Va. Their first ships were the *Jamestown* and *Roanoke,* wooden paddle-wheelers, built in 1851, each 1,070 tons gross, 218 feet by 32 feet by 16 feet, with double beam engines, having two cylinders each 42 inches in diameter by 10 feet stroke. In 1858 a larger ship, the *Yorktown,* was added. At the outbreak of the Civil War the above vessel and the *Jamestown* were seized by the Confederate authorities, transformed into gunboats, being re-named *Patrick Henry* and *Jefferson,* respectively. They took part in the *Monitor-Merrimac* combat, and the *Patrick Henry* was afterwards anchored in the James River below Richmond and turned into a school ship for Confederate naval officers. At the evacuation of Richmond she was blown up.

The *Roanoke* escaped seizure and continued in service in the North, but curiously enough was also eventually destroyed by the Confederates. In 1864 she was running as a mail steamer between New York and Havana, and on Sept. 29, while on her passage from the latter port, she was seized by Lieutenant John C. Braine and a party of men belonging to the Confederate navy who had come on board as passengers at Havana. The regular crew and passengers were then transferred to a passing sailing vessel, and on Oct. 9 the *Roanoke* was burned off Bermuda by the Confederates.

Launch of the Chinese Cruiser Fei Hung

The Chinese cruiser *Fei Hung* was launched at the yard of the New York Shipbuilding Company, Camden, N. J., on May 4. This ship, designed as a training ship for Chinese officers and men, is in reality a protected cruiser of the following principal dimensions:

Length between perpendiculars.....	320 feet.
Breadth, molded	39 feet.
Depth, molded	22 feet 6 inches.
Mean draft	14 feet.
Displacement (about).....	2,600 tons.
Speed (about).....	20 knots.

The hull is divided into numerous compartments by watertight bulkheads and flats. A double bottom extends throughout the machinery space, in which stowage is provided for feed-water for the boilers.

The armament consists of two 6-inch rapid-fire guns, located, respectively, on the forecastle and the poop decks; four 4-inch rapid-fire guns on the upper deck at the sides (two just abaft the forecastle and two just forward of the poop); two 3-inch rapid-fire guns, on each side of the upper deck amidships; six 3-pounder guns, three carried on each side of the upper deck; two 1-pounder guns, located on the after end of the forecastle deck, and two 18-inch revolving torpedo tubes placed on the upper deck aft of amidships.

The vital parts of the vessel are protected by an armored deck of the arched type, fitted in the vicinity of the waterline and extending throughout the entire length of the vessel. The coal bunkers are so arranged along the sides of the vessel, both above and below the protective deck, as to give a maximum protection from gunfire. The ammunition for the large guns is taken through armored tubes on its way to the guns, and an armored conning tower is built on the forecastle deck, while an armored tube protects the gear rods, etc., passing from the conning tower to under the protective deck. The searchlight platform and navigating bridge are located over the after end of the forecastle bridge. A searchlight platform is also fitted over the fore end of the poop. The 6-inch guns are served by electrically-operated ammunition hoists. The two masts are made suitable for taking a wireless telegraph installation of 200 miles range.

Accommodation is provided for a complement of 232 officers and men. A large forecastle and poop are built above the upper deck at the ends of the vessel, which provide accommodation for the petty and warrant officers, etc., aft, and for the captain and chief officers forward. Under the upper deck forward and aft accommodation is provided for the crew. The galleys are placed in the casings on the upper deck amidships, and the steam and other boats are carried on skid beams and in davits along the sides of the upper deck. Under the protective deck forward and aft are placed the magazines, shell rooms, storerooms, fresh water, fuel oil, etc. Cold storage for the preserving of meats, vegetables and fish is placed above the protective deck amidships. The ship is lighted throughout by electricity.

The propelling machinery is of the Parsons turbine type, with three lines of shafting. The turbines are arranged in one engine room, as follows: Center shaft, one main high-pressure turbine with extra stage for cruising purposes; starboard shaft, one low-pressure turbine, one backing turbine; port shaft, one low-pressure turbine, one backing turbine. The astern turbines are fitted in the same casings as the low-pressure turbines. By-pass valves are fitted around the first expansion of the high-pressure for cruising purposes. All the turbine bearings and shaft bearings are arranged for forced lubrication, pumps being supplied for this purpose, together with an oil cooler and tanks, etc. The shafting throughout is of forged steel. The propellers are three-bladed, the bosses and blades being cast solid of manganese bronze; the center and starboard propellers turn right-handed and the port turns left-handed.

There are two condensers—one in each wing of the ship. They are cylindrical in form, with the castings built up of steel plates and angles. The circulating water is supplied by two pumps of the centrifugal type, driven by independent single-cylinder engines; these pumps are also arranged to draw from the bilges. The main air pumps are independent, direct acting, two in number, one for each condenser.

The two evaporators have a combined nominal capacity of 9,000 gallons of water per twenty-four hours for boilers and of 6,000 gallons of additional water in twenty-four hours. The two distillers have a combined nominal capacity of 6,000 gallons of water per twenty-four hours. The evaporators take steam from the main steam pipe, and the steam-head drain pipes lead through, and by-pass, automatic traps, to the feed tanks and main condensers. The shells of the evaporators have connections for directing the steam into the distillers and into the auxiliary exhaust pipe. The feed-water for the evaporators is taken from the circulating pipes, after it has passed through the distillers, and from the sea.

There are three boilers of the Thornycroft watertube express type located in two fire-rooms—two in the after and one in the forward fire-room. The latter is fitted for burning oil as well as coal. The water drums for these boilers were built by the Continental Iron Works, Brooklyn. The total heating surface is about 14,500 square feet, and the total grate surface about 271 square feet. Air is supplied to the fire by three blowers especially provided for that purpose. These blowers are of the Sirocco type, designed and built by the American Blower Company, Detroit, Mich., and are driven by Terry steam turbines, built by the Terry Steam Turbine Company, Hartford, Conn. These sets run at a speed of 1,220 revolutions per minute, and are supplied with steam from 150 to 225 pounds, discharging against a back pressure of from 5 to 10 pounds. Each set is capable of supplying 30,000 cubic feet of free air per minute against a static head of 3 inches of water.

The oil firing system for this vessel was furnished by the Schutte & Köerting Company, Philadelphia, as were also the feed-water heaters. All of the relief valves were supplied by the American Steam Gauge & Valve Manufacturing Company, Boston. The plumbing is by A. B. Sands & Son Company, New York.

It is estimated that $20,000,000 (£4,100,000) will be expended in the next five years for the development of the harbor of Seattle, Wash. In addition to extensive terminals now installed by six transcontinental railroads in this city, the Seattle Port District, March 5, voted $8,100,000 (£1,670,000) for the construction of dockage facilities, including $5,000,000 (£1,030,000) for the acquisition of the site and erection of six concrete wharves, 1,400 feet long and 150 wide, accommodating forty large steamships at one time. This port expenditure is for the purpose of instituting terminal facilities similar to the Bush terminals in Brooklyn, N. Y., and the city expenditures are to be duplicated by a New York corporation. This company intends to erect seventy buildings, including several six-story concrete industrial plants for the accommodation of manufacturers, together with modern storage warehouses with every facility for handling raw and finished products.

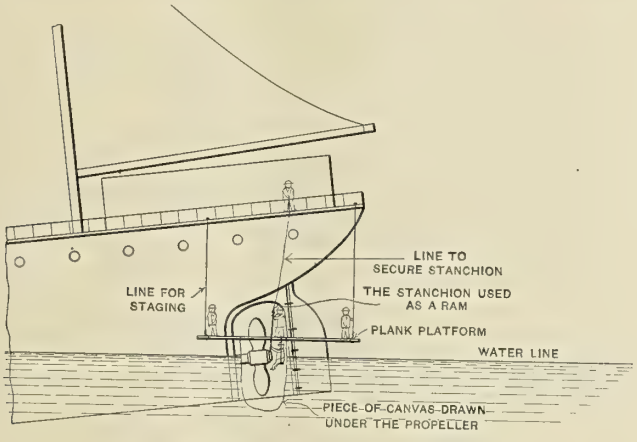
Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Tightening a Loose Propeller

Reading Mr. R. C. Hill's letter, "Fitting a Tail Shaft Ring," which appears in the current issue of the paper, brings to mind an incident in my own experience of a few years ago. It was on the *Orinoco,* a mail, passenger and freight steamer plying between New York and the West India Islands. I was fourth engineer at the time. It was sailing day, and we were just about to leave the pier, when the second engineer, in working the engines alternately ahead and astern, felt a slight jar at each reversal, which he interpreted to mean that the propeller was loose on the shaft. The chief was called, and he, too, worked the engines, but he professed to believe that the wheel was not loose, and so we started the voyage, some of us in doubt as to the outcome.

The first port of arrival was in the Island of Antigua, one of the British West Indies. We were six days getting there, and during that time all doubts about the wheel being loose had vanished; even the chief changed his opinion and became convinced that the propeller was loose in reality. We came to anchor, and a consultation was held as to what was best to do. The nearest dock was at the Island of St. Thomas, quite a distance from Antigua, Finally it was decided to trim the ship by the head, as described in Mr. Hill's letter, and make the attempt to secure the propeller again. The ship was

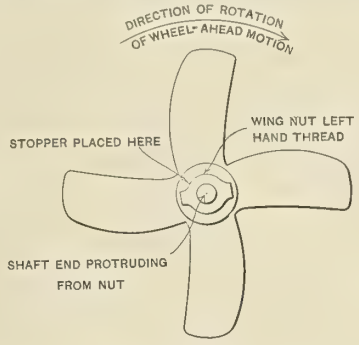

LINE TO SECURE STANCHION
LINE FOR STAGING
THE STANCHION USED AS A RAM
PLANK PLATFORM
WATER LINE
PIECE OF CANVAS DRAWN UNDER THE PROPELLER

RIGGING FOR REACHING LOOSE PROPELLER

trimmed enough to just bring the propeller hub about level with the surface of the water. A staging was built, or rather slung, from the quarter-deck railings, from which we could get at the wheel. As there were quite a few sharks swimming around, a piece of canvas was run under the wheel and secured to the staging at the corners, and a man was stationed at each of the four corners of the staging to frighten off any of the finny tribe that might venture too near.

The nut was found to have slacked back against the stop, which stop had not been set up tightly against the nut, as it should have been. The amount of slack was not great, but enough to permit of the slight movement of the wheel on the shaft as at first noticed at the pier in New York.

The shaft was 13 inches diameter, and the largest sledge hammer we had on board was too small to make much impression on tightening the nut. However, some one suggested cutting out one of the 'tween deck's stanchions—which were about 3½ inches diameter, and possibly 10 feet in length—and using it on end as a battering ram to tighten up on the large nut. This was done. One of the engineers straddled the shaft where it projected out from the nut, and bracing his back against the rudder post guided the striking end of the improvised "ram," while others of the crew raised up and struck alternately blow after blow until the nut was up as tight


DIRECTION OF ROTATION OF WHEEL AHEAD MOTION
STOPPER PLACED HERE
WING NUT LEFT HAND THREAD
SHAFT END PROTRUDING FROM NUT

DETAILS OF PROPELLER

as the stanchion could make it under the attending circumstances. A rope had been attached to the top end of the stanchion and secured on deck in case of an accident, whereby we might lose our "ram" in the harbor.

The stop was set up against a wing of the nut this time, and that makeshift repair carried us back safely to New York, where the ship was docked and the job properly done.

Scranton, Pa. CHARLES J. MASON.

Fire Extinguishing Apparatus

I have read with much interest the description in your March issue of a new fire extinguishing apparatus. There are some points in connection with this plant that will, I think, be of interest to your readers.

The gas generated by plants of this type generally contains about 10 to 11 percent of sulphur dioxide and about 9 percent of residual oxygen. In the apparatus which you describe the gases, according to your article, are diluted by the air in the injection apparatus on the delivery side until the proportion of sulphur dioxide is reduced to about 6 percent. The air necessary to produce this amount of dilution contains 21 percent of oxygen, and therefore a quantity of air has been added sufficient to raise the percentage of oxygen in the gas that has to be used for fire extinction from about 9 percent to over 14 percent. Now the oxygen in the atmosphere must be reduced to at least 15 percent before the atmosphere is fire extinctive. If, therefore, the gas used in this system is fire extinctive at all it is only so to a very slight degree, it is obvious that before this gas would have any effect in extinguishing a fire the whole of the air would have to be displaced from the ship's hold before the fire could be arrested.

If the sulphur dioxide apparatus which you describe gets slightly out of order or the air valves are not properly adjusted, I think the plant would act as a fan to blow up the fire and not as a fire extinguisher at all. The difficulty in getting all gaseous extinguishers to work effectively lies in their not being able to supply the fire extinctive gases in the large quantities that are absolutely necessary for this purpose.

I am unable to understand from your article why the makers should expect the gas to corrode the fans and not the parts of the ship with which it comes in contact. AN ENGINEER.

EDITOR'S NOTE:—In reply to the above criticism the designer of the fire extinguishing apparatus referred to has the following to say:

I am always glad to answer criticism from one who evidently knows what he is talking about. In this case, however, your correspondent is reasoning from false premises, due to the fact that the article in question is not quite clear enough.

The apparatus described is designed for two purposes—fire extinguishing and fumigating. When used for fire extinguishing the full strength of the gas, say 15 percent or more, is used; the injection device on the delivery end is used only when it is desired to use the gas for fumigating. The testing instrument used in connection with the apparatus will show at once the required strength of the gas.

Furthermore, the manner of introducing the gas by this method precludes the possibility of mixing the gas with the air of the hold because of its greater specific gravity than air. The gas goes to the bottom, and as the space fills up the air is simply boosted upward and out. If we were simply talking from theory there might be room for discussion, but these are facts ascertained from practice.

A very good opportunity to observe the action of this gas in a ship's hold is when we fumigate the empty hold of a ship. I have often on such occasions left the hatch cover off for a time and looked down. The gas will form in the bottom of the hold as one may have seen a dense fog in a valley in the early morning with the atmosphere perfectly clear above

I must also take exception to another point in your correspondent's criticism, namely, as to the percentage of gas necessary to stop combustion. I have seen a 5 percent gas knock down flame and stop active combustion and thus bring the fire under control; we, however, advocate the use of a 15 percent gas, and this we have maintained for twelve consecutive hours without appreciable variation with our apparatus.

The interesting question which is raised in regard to the action of the gas on the blower in other apparatus I would answer in this way: The air used in the furnace contains, of course, the ordinary percentage of moisture, which by the heat of the furnace becomes steam; in the cooling of the gas before it leaves the apparatus this steam is condensed to water; the well-known affinity of water for SO_2 gas causes this water to absorb enough gas to become sulphurous acid, which passes through the blower, and what remains in the pump or blower is what does the damage. In this apparatus this acid can be drained off and never reaches the ship, and, of course, in this apparatus it does not pass through the blower, as only air passes through the blower. The reason, however, why sulphurous acid will destroy a blower and yet not damage the ship lies in the fact that corrosion of metals by acid is due to rapid oxidation, which only takes place, as in the case of a pump or blower, where the surfaces are continually wiped clean by the action of the machine. This condition does not prevail in the hold of a ship even should some acid reach there. At any rate, I have never found during many years' experience any damage done to a ship from this cause, but I have found blowers eaten to such an extent as to be inoperative, and this is usually discovered about the time you want to use it. PAUL H. GRIMM.

Unaccountable (?) Mysteries

No one who has been to sea in the engine room, or about engines ashore, but will have bucked up against the mysterious. Strange sounds that could not be accounted for in the main engine, or some erratic action of an auxiliary, or something that seems utterly inexplicable, is pretty sure to be met to set one wondering and thinking.

I used to almost think and worry my hair off in trying to account for noises, but I got so after a while that I did not fret myself so long as there was water in the gage glasses and no bearings hot. What makes me provoked is that time and time again I start in after a mystery and am ashamed of myself when I find it out, as it is always very simple after one knows the cause.

I was working over on a river, across the water, where at that time you could get a fight any Saturday night if you just called out "boil the bell" to any of the lads who were working at the yard below us. I wonder if any of your older readers who hail from the other side can remember the following story:

A ship came in for repairs, and some "prentice" lads were set to painting, which did not seem to please for some reason, so to do a good job they painted everything in sight, including the ship's bell. They gave it several good coats, at which the captain became proper mad when he saw the work and complained about it, and the men were set to work scraping the bell. But it was slow work, so someone proposed to unship the bell and boil it. This was done, but for some reason this treatment took the life out of it and made it sound as dead as a door nail, and another jolly row arose again. All hands got to guying the yard about the bell, and pretty soon it got on their nerves, as they say over here, and it was not safe to mention boiling a bell unless you had a chance to run for it, or wanted to put up your "dukes."

Well, I got off my story about mysteries. We had just fitted up a tramp, which was rather a high-toned affair for its class, and I was detailed to look after indicating the engine on her first run. The engine designer was aboard. I think it was the first "triple," so he was keen after the cards. After we got things going well I took cards from the high and intermediate, and they were very good, but when I came to the low I got a good card from the bottom end but never a line from the top. I got the designer below, and he went wild and just handed it out to the erecting boss, who handed it back, but no one could say what the trouble was, and the designer and the erecting boss did not speak the rest of the trip.

The indicator piping was a good-looking job, such as is usually put up, and I could see no reason for the mystery, and it troubled me no end. I thought that the indicator steam passage must not have been drilled through; but all hands swore that the work had been done properly, and to clinch it one of the drafting room force had a photograph made of the low-pressure cylinder, and it plainly showed the drilled hole, so I was, so to speak, still at sea.

One afternoon I was working about the erecting floor, where there was an engine about done, and the lagging gang came along to start the lagging. The gang boss had a big sheet of thick detail drawing paper, and he proceeded to lay it on the cylinders and cut out for the bosses and openings, so as to make a template to cut his sheet metal to. To do this he had the paper held to the cylinders, and he took a hammer and peaned around the bosses and holes, cutting the paper on the edges of the metal by the blows. I was watching him, when suddenly it came to me what was the cause of the mystery of the top end of the low-pressure cylinder, so I kept a sharp lookout, and sure enough when he peaned the paper at an opening a little circle like a gun wad was cut out, and it sometimes remained in the hole, and no doubt but that in the hurry to get the work done the wad was left in the top end indicator opening, and it, of course, acted like a blind gasket. I got hold of the "second" when the tramp next made port, and he told me that he got cards all right from the low, and he had noticed that when cleaning his indicators the one he used on the low was stuck up with some messy pulp, which was no doubt the remains of the mystery. COUPLING.

Port Antonia, W. I.

Review of Important Marine Articles in the Engineering Press

The Raising of the Wreck of the United States Battleship Maine.—The official report of the preliminary operations of the raising of the *Maine* contains all details of the plans and carrying out of the same up until the completion of the cofferdam. Complete data of the most important part of the undertaking, with an account of the hurricane that hindered the work the latter half of October. 5,100 words.—*Engineering,* March 15.

Making Wax Models of Vessels.—An illustrated description of the process of making models in wax for towing in the model tank of the British Government in the National Physical Laboratory at Teddington. The process, briefly stated, is as follows: The wax being first heated in a tank capable of holding about 1½ tons and the impurities being removed, the rough mold for the model is cast. Upon being cooled the top side is planed perfectly smooth and then turned upside down to permit the cutting of the water lines in the body of the model. This is done by a rotary cutter guided by a pointer run over the lines of the ship and magnified in transmission to the size of model desired. With the water lines all cut, the rough places between are smoothed away until the model is fair. As a check upon this last operation a second series of cuts is made at the transverse stations. A verifying gear enables the form of the model to be traced back upon the drawing, thus proving the closeness of the similarity of the two. 1,400 words. Photographs and drawing.—*The Marine Review,* March.

The Case Against Increase in Caliber of Naval Guns.—An editorial review of a paper by Count Alessandro Pecori Giraldi, director of the Armstrong Works, Pozzuoli, which was read at the first Congress of Italian Naval Architects and Mechanical Engineers, held at Rome, Nov. 11 to 13. The Count is not adverse in his opinion to larger caliber guns considered *per se,* but when the necessary larger displacements must be arranged he endeavors to show that present large caliber guns are large enough. His principal argument is based upon a series of tests of armor and armor-piercing projectiles made with Krupp cemented steel plate. These tests showed that 12-inch projectiles of the 1910 model could pierce 16.1 inches of armor at a range of 4,400 yards and 12.6 inches at 7,700 yards; these figures applied to normal firing. Since these ranges were considered a maximum for effective firing in actual battle, and since the maximum armor belts of battleships now built and building were 12 inches, this size gun was considered sufficiently effective. Other considerations touched upon were weight involved and ease of serving of guns of the different sizes. 1,800 words.—*Engineering,* January 19.

Motors for Lifeboats.—The use of motor-driven lifeboats is becoming more general, there being at present nineteen in service on the English coast. This article describes the peculiar conditions of the service, the unusual requirements for motors so used, and a description of the boats now in use, together with tabulated data of the same. The latest views of Captain Holms, chief inspector of lifeboats of the Institution, and Mr. Small, his technical assistant, are given on the qualities required in the engines and their fitting up. Some of the most interesting and unusual of these are: Number of cylinders to be in all cases limited to four; no aluminum used in any part; reliability run for every engine of twelve hours without being touched; carburetor and magneto to be placed high, low-tension magneto preferred; valves to be on opposite sides with separate camshaft for each set; ability to run while boat is hauled up on slip with inclination of 1 to 4 longitudinally; ability to run while boat has a list of 25 degrees either way or a momentary list of 45 degrees, and, finally, that an arrangement be installed to automatically cut off ignition if the boat is heeled to an angle of 60 or 70 degrees, so that if the boat is capsized engines will not continue running and leave crew in the water. It is admitted that if anything happens to the motor when on active service very little more than adjusting a plug can be done by lifting a flap and protecting the opening with a dodger. If the trouble is more than this it is simply let alone, and masts and sails are raised or oars put out and the best progress possible made under the old conditions. Illustrated by photographs of the different motors used. 5,800 words.—*The Engineer,* March 1.

Internal-Combustion Engines for German Fishing Boats.—By F. Romberg, Charlottenburg. A review in English of this rather extensive German paper. The principal object is to show the development within the last five years of German engines for use in the fishing service. Previous to that time this field was supplied by foreign makers, either English, Swedish or Danish. Since then a very acceptable engine has been manufactured by the Gasmotorenfabrik Deutz, which is described in detail in this article. Illustrations of the engine, assembled and in detail, are shown, together with important designing and operating data. As to principal characteristics, it may be said to be a four-cycle, two-cylinder engine, with cylinders 200 millimeters diameter and stroke of 240 millimeters, running at 340 revolutions per minute. This gives a piston speed of about 540 feet per minute. Mean effective pressures have run as high as 61.7 pounds per square inch. Only in Diesel engines has this been higher. Since the pressure at the moment of explosion runs up to almost 750 pounds per square inch all important parts must be made heavy. Weight is not prohibitive in this service, but the main consideration besides simplicity is small space required. That this is realized is well shown in a drawing of a general arrangement accompanying. Other motors in use in this service are very briefly mentioned in the review. 1,900 words.—*Engineering,* March 1.

Semi-Diesel Engine on the Yacht Mairi.—A practical experiment by the Marquis of Graham upon this type of engine, which he has fitted to a private yacht and will run tests thereon, for the purpose of obtaining data upon points of design and performance with a view to finding the most suitable type of motor for oil consumption. This engine differs from the Diesel in having compression limited to 150 pounds per square inch and explosion pressure never greater than 300 with the lighter oils, and it is said never to exceed 200 pounds when using heavier oils, such as the Texas or Solar. A combustion chamber is needed for the starting of the engine, but after the first few minutes the heat of the cylinders is sufficient for ignition, and the usual Diesel cycle, with the exception of the excessive pressures, is gone through with. The engine works on the two-cycle principle, and has four working cylinders with a two-stage air compressor working off a fifth crank. It is reversible, and in recent runs has shown its ready maneuvering qualities. The cylinders are 9 inches diameter and 13 inches stroke, with designed speed of 350 revolutions per minute. The primary balance is complete, as shown by the fact that its running without vibration at 400 revolutions per minute. The motor yacht in which this engine is installed is 85 feet over all, with steel hull designed to highest class of Lloyd's Yacht Rules. On trial the *Mairi* made 10.3 knots, the engine turning the normal number of revolutions and developing 130 brake-horsepower. At this speed the

oil tanks have a capacity providing a cruising radius of 1,000 sea miles. 2,600 words. Illustrated with photographs and drawings.—*Engineering,* February 23.

The Towing Machine.—By Mr. Thomas W. Wilson. A paper read before the Institute of Marine Engineers Feb. 26. After explaining the need of such a device as the towing machine, due principally to the short life of hawsers without them, the author enters into a detailed description of various makes of towing machines as used in the American coasting, and to a less extent, in the foreign trade. While the manila hawser answers to a limited extent, the need of a spring between tug and tow, the great strain endured and exposure, render its life short, and after one trip its useful strength is much diminished. The towing machine is in itself a large winch, which receives the towline wound on the drum, the pull on the line being taken up by the pressure in the cylinder. The elasticity of the steam utilizes the load and enables the tug to make better time with the same load by automatically taking in or paying out the line as the pressure decreases or increases, respectively. The author describes in some detail the Shaw-Speigell machine, which was perhaps the earliest form used. A very complete analysis of the type manufactured by the Chase Machine Company follows, together with drawings and photographs. 3,900 words.

Modern Ore Handling Plant.—For the past two years the Pennsylvania Railway has been building a new ore-handling plant at Cleveland, Ohio. The growth of the Lake freight steamship made the previous docks undesirable, and so the new yards were begun on the outer harbor in the west breakwater. Approximately 1,000,000 cubic yards of filling were required to make the new land 1,850 feet long by 850 feet wide. The dock consists of a double row of 40-foot concrete piles supporting a concrete superstructure reinforced with 85-pound rails. The ore unloading machinery placed on top of this consists of four 17-ton Hulett unloaders and a 15-ton ore stocking and rehandling bridge. It is expected that when completed this will be the most complete ore handling plant on the Great Lakes. It is expected to be ready for operation at the opening of navigation this season. The article shows plans and photographs of the work and a complete description of the method of building and the method of working when completed. Making and driving of the reinforced concrete piling, operation of the Hulett unloaders and the ore conveying bridge receive detailed attention. The whole plant, including the handling of cars near the unloaders, is operated by electricity, a special power plant being provided. 4,500 words.—*The Marine Review,* March.

One Thousand-Horsepower Two-Cycle Diesel Engine.—The engine mentioned in the title and others manufactured by Messrs. Sulzer Bros., of Winterthur, are briefly described in this article. Although both two-cycle and four-cycle Diesel engines are made by this firm, the general pattern for both is the same. For powers up to 700 horsepower and for stationary plants the four-cycle type is recommended in preference to the two-cycle; the former does not require scavenging, but its flywheel is more than twice as heavy as that for a two-cycle engine of equal power. The use of two-cycle engines for powers greater than 700 horsepower requires a separate scavenging pump; but this forms a comparatively less important feature from the purely practical standpoint for the larger engine, because it does not supply compressed air at high pressure. There are given illustrations and descriptions of a 200-horsepower, four-cycle Diesel engine running at 375 revolutions per minute, a 1,000-horsepower, two-cycle Diesel running at 150 revolutions, and a two-cycle, six-cylinder marine Diesel engine. Following these is a statement of fuel consumption at reduced loads taken from exhaustive tests, showing that for reduction of power to one-fourth normal, fuel consumption per unit of power rises only 14 percent. 1,700 words.—*Engineering,* March 8.

The Marine Oil Engine.—A lengthy editorial on the present state of development of the marine oil engine, its problems which are most pressing for solution, and the tendencies of owners and builders toward favorable action for the new form of propulsion. Plans seem to be formulated too quickly for engines of large size of this type. For, while designs are said to have been made for battleship installations, the highest power yet developed in one cylinder is 2,000 horsepower, and that not without difficulty. There is now in course of construction by the Messrs. Krupp an engine to develop 3,500 horsepower; but this is done in twelve two-stroke cycle cylinders, which could scarcely be said to point to higher powers in the near future. The editors hold that the most useful thing to be done at the present time is the careful consideration of the mechanical difficulties encountered and the decision, from data obtained in experience to the present day, of such questions as the best type to use of the two or four-cycle, single or double-acting engine. Another question of importance to the marine engineer is that of auxiliary machinery. This has been met temporarily in several ways, but there is much to be learned as to which of these is most practicable. The question of obtaining oil fuel at reasonable prices is apparently not considered of prime importance by owners who are rapidly installing oil-burning systems under steam boilers. With the added experience of a year or two regular running free from breakdowns, these same men might be persuaded to install oil engines. For such reasons as these progress should be made slowly but surely at this time, when observation is critical. 3,400 words.—*Engineering,* March 8.

On the Wider Adoption and Standardization of Watertube Boilers.—By Mr. E. M. Speakman. A careful study of boiler installation requirements with the object of showing that watertube boilers could be advantageously considered for many ships not now using that type of steam generator. The author gives tabulated data showing types of boilers adopted by different navies, percentage of total boiler weights to displacement weights of vessels of different classes, structural data, including space required, weights and capacity of several types of watertube and cylindrical boilers. Drawings and photographs of the different types are shown, and in an appendix are carefully worked out problems in boiler design showing saving in weight and space of installations of watertube instead of cylindrical boilers. Throughout the paper reference is made to the gradual elimination of the differences in types and the increasing standardization of parts. This is most strikingly shown in the more concentrated use of a few well-known types whose excellence is becoming widely known. The article, which was a paper read before the Institution of Engineers and Shipbuilders in Scotland, gives much excellent data for general computing of boiler plants for marine work, and while of sufficient length to be given in three sections, all its paragraphs are well packed with useful information in the minimum of space. 12,000 words.—*The Engineer,* March 1, 8 and 15.

Wireless Telegraphy.—By Mr. John McLaren. Since wireless telegraphy has been so generally introduced in the merchant marine, a thorough understanding of its principles and operation is becoming more and more a necessity to the marine engineer. With the purpose of covering just this field, Mr. McLaren has prepared a very complete paper on the subject, and has furnished some interesting and instructive facts and figures on the Marconi system as commonly used in the British merchant marine. The apparatus described is illustrated by photographs and drawings. 8,350 words.—*Transactions Institute Marine Engineers,* March.

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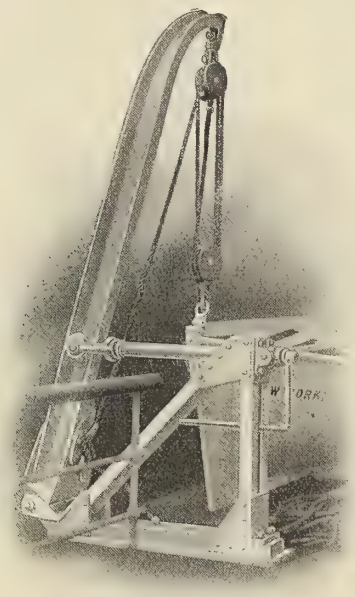
When it was predicted in these columns over six months ago that a revival in shipbuilding in the United States was about to occur, many of the business men in the marine field, who had suffered seriously from the recent depression in American shipbuilding, were reluctant to accept this prediction. To-day, however, those who are in close touch with the shipbuilding industry realize that this prediction has already been substantially verified, and that as soon as Congress has definitely settled the question of Panama Canal tolls in a just and equitable manner the activity in shipbuilding will assume far greater proportions than have been expected. Since the first of the year orders have been placed with United States shipbuilders for over 110 steamships of various classes. With one exception, these are all for coastwise trade. One steamship company has placed orders for 80,000 tons of shipping during the last six months, an order which has never before been equaled in American shipping history. Nearly all of the large shipyards on the Atlantic Coast have enough work on hand at the present time to keep them running at full capacity for more than two years. In some yards it is impossible to place an order for delivery inside of eighteen months. While the present condition is extremely satisfactory, there are still bigger prospects awaiting the decision of Congress in regard to the question of Panama Canal tolls, which will be an important factor in determining the immediate future of American shipbuilding.

In matters pertaining to inland navigation, and more particularly to ocean navigation, all maritime countries in the world are becoming more dependent upon one another, as far as methods of development are concerned. Water-borne commerce itself has experienced a tremendous growth during the last few decades, and there is every prospect of a still more marvelous growth in this direction in the immediate future. As oversea and inland water-borne commerce develops, however, there is imperative need for improvement in all matters related to navigation. For this reason the work of the International Congress of Navigation, a brief account of which is given in this issue, becomes of great importance; for here the ablest minds in the engineering profession from practically every maritime country in the world contribute their quota of practical experience in carrying out such work. The subjects considered naturally fall under certain heads, such as the improvement of inland waterways and ocean harbors, the practicable dimensions of such waterways and their relative effect upon the size of vessels, the types of construction used in such work, the mechanical equipment of ports and various other problems relating to the safety of navigation and the economy of water transportation. The first conclusion reached in the consideration of nearly all of these problems, however, is that no steadfast and uniform rule or method of development can be adopted, because the natural conditions differ so much in nearly every case that each problem must be considered by itself, so that its particular requirements can be met. This is particularly true in matters relating to inland navigation, although in ocean navigation more uniformity can be reached, as practically the same or similar means of transportation can be used in almost every port. But in whatever aspect, on account of the varied natural conditions in different parts of the world, any of these problems is presented, there is always something to be gained from the experiences which others have had in working along similar lines, and in the end certain features which have proved successful under somewhat different conditions can be adapted to the problem in hand. Therefore, the International Congress of Navigation, while it cannot establish fixed standards which can be followed in all places and under all conditions, can, by furnishing a vast amount of practical information on what has been done in matters pertaining to navigation, become a valuable source of information and serve an eminently useful purpose.

Improved Engineering Specialties for the Marine Field

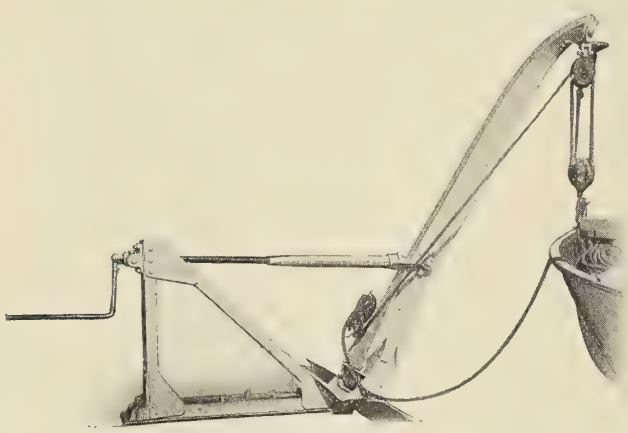
Sheath Screw Davits

A simple mechanically-operated davit for handling lifeboats on board ship has been invented and placed on the market by Mr. H. F. Norton, chief draftsman of the hull department of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. By simply turning a crank at each davit the boat is raised from its chocks on the deck and swung out from



SHEATH SCREW DAVIT IN STOWAGE POSITION

the side of the ship, when it can be lowered in the ordinary manner by the use of falls handled either from the deck of the ship or from the boat itself. The construction of the davit, as shown in the illustrations, is very simple. The davit arm is of structural steel; it swings about a fixed pivot which is supported at the gunwale of the ship. The movement of the davit is obtained from a tobin bronze screw operating in a sheath



SHEATH SCREW DAVIT SWUNG OUTBOARD

of steel pipe. The screw is supported by a structural steel frame. It is thus seen that the pivot for the davit is supported at a point where the structure of the ship is naturally strongest, and most of the fore-and-aft stresses are taken up at this point. The athwartship channel on the deck may be readily supported on top of a wood deck, or where desirable it may be incorporated with the deck frame. For instance, on the navy colliers building at the Maryland Steel Company these davits are being installed with the framing attached directly to skid beams.

One of the most striking advantages of the sheath-screw davit is that in stowage position the screw is completely in closed in the sheath. The sheath may be filled with grease by removing a small plate at the end, and although left almost indefinitely the screw will be thoroughly lubricated whenever the davit is used. It is by the same means protected from clogging with dirt or ice. It will be noticed that there are no guide sheaves of any kind for the falls. The davit being pivoted to one side of the boat chocks naturally lifts the boat clear of the chocks as it begins to swing out. This davit involves no complicated mechanism, so that anybody who has ever turned a crank or worked a pulley block can launch the boat successfully, whether he is a sailor or a "landlubber." These davits have already been fitted on the New York & Porto Rico Steamship Company's steamer *Isabella,* and are being fitted on the navy colliers and American-Hawaiian steamers now building at the Maryland Steel Company, Sparrows Point, Md. They are also under consideration for various other vessels building and for installation as auxiliary boat equipment for vessels now in commission.

The Lundin Decked Life Boat

A new type of lifeboat has recently been thoroughly tested by the United States Steamboat Inspection Service with very favorable results. The boat is the invention of Capt. A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y., who are the manufacturers of the boat.

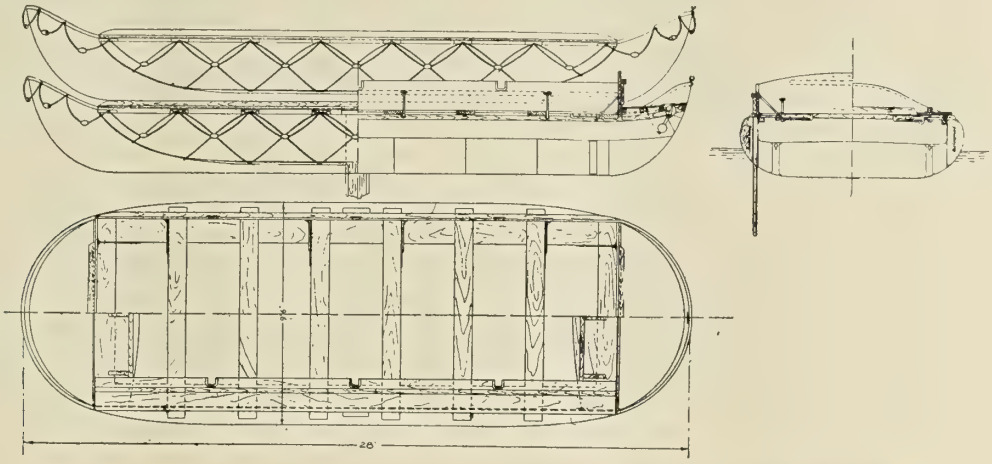
As shown by the illustrations the boat is built practically on the lines of a Norwegian skiff, with the exception that both ends of the boat are alike. The lines therefore insure by experience a seaworthy boat, which can be easily rowed, sailed and maneuvered when loaded to its greatest capacity. The hull has a flat bottom with rounded ends and flat sides. It is constructed of galvanized iron or other metal, the only woodwork used being the reinforcement over the gunwales,

LUNDIN LIFEBOAT LOADED TO FULL CAPACITY

the thwarts, the folding sides and ends above the fixed gunwale, besides light Balsa wood fenders on each side of the boat and small raised decks forward and aft.

The type of construction used in the boat is shown by the 'midship section. A watertight metal deck is fitted throughout the length of the boat, so that the lowest point of the deck is about 3 inches above the waterline when the boat is loaded to its full capacity. The space underneath the deck is subdivided by transverse watertight floors into a number of watertight compartments, one of which is fitted with a manhole plate for storing provisions, etc. Thus the boat is in reality a double bottom boat with numerous watertight com-

partments, so that it is practically unsinkable, and, due to its broad beam and buoyant fenders, is practically non-capsizable. The deck is provided with a self-bailing arrangement, by means of a suitable number of drain pipes fitted through the bottom of the boat, so that any water shipped in a rough sea will run out while the entrance of water from outside pressure is prevented.



GENERAL ARRANGEMENT OF LUNDIN LIFEBOATS, ONE STOWED ABOVE THE OTHER

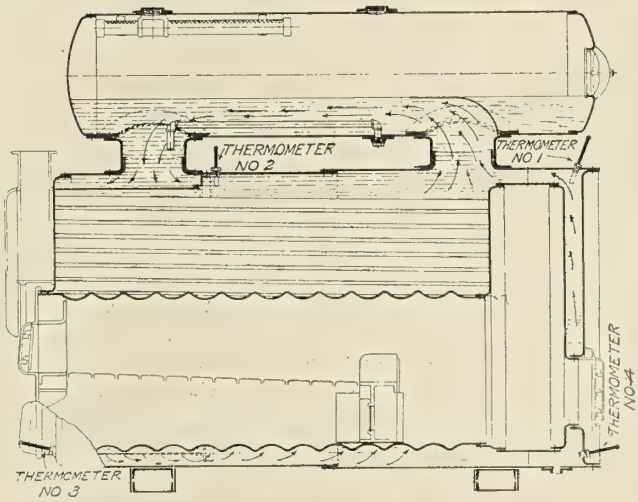
For the accommodation of passengers the space above the deck is fitted with thwarts and side benches on top of the fixed gunwale. The sides above the thwarts are made of wood, and are so arranged that they hinge down flat on top of the fixed gunwale, so that they can be raised in a second and automatically locked in place by means of sliding braces; protecting boards are then dropped into the ends. Oar locks are provided at each side, and a steering oar lock on each end. A wooden leeboard can be dropped in a pocket between the fender and the side of the hull on either side, so that the boat can be handled under sail. Water tanks are secured under the fore-and-aft thwart, one on each side amidships, and the spaces between the metal deck at each end of the boat provide a convenient place for storing various provisions and lifeboat equipment. The oars are secured with brackets on the outside of the folding sides, and masts can be secured to the top of the fenders, so that the inside of the boat is entirely unencumbered for occupancy by the passengers and crew.

The boat shown in the illustrations is 28 feet long over all, 8 feet beam of the hull proper, and 9 feet 6 inches beam over the fenders. The depth from the bottom to the fixed gunwale is 2 feet 8 inches and the depth to the top of the sides when raised 3 feet 11 inches. The capacity is sixty persons. For a given length of hull the manufacturers claim that these boats have about 20 percent more capacity than the regular type of lifeboat, and, inasmuch as when the hinged sides are folded down two can be conveniently stowed within the same space one above the other, in a given deck space of, say, 28 feet it would be possible to take care of 120 persons instead of only 50, which is the maximum carrying capacity of a 28-foot lifeboat of the regular type.

One of the most important features of the boat, however, is the stability and seaworthiness, which were thoroughly demonstrated at the test by the United States Steamboat Inspection Service. After loading the boat with sixty-two people the increased draft amounted to less than 5 inches more than when the boat was empty. Consequently, as can be seen from the photograph, there is a very substantial freeboard, exclusive of the folding sides and ends. By crowding the entire load to one side of the boat it was found impossible to bring the fixed gunwale below the waterline. The reason for this great buoyancy and stability is due principally to the large and extremely light Balsa wood fenders secured to the sides of the boat, and also to the fact that the watertight subdivisions in the hull, located to the best advantage, provide a greater amount of reserve buoyancy than is available in a regular lifeboat.

Circulating Test of a Robb-Brady Scotch Boiler

The Robb-Brady Scotch boiler is a modified form of the standard Scotch marine boiler, with changes from the standard form which, it is claimed, greatly increase the circulation. The heating surfaces are arranged as in the standard form, and there are the same internal furnace flues, but there are two smaller shells, one above the other, in place of the large one, and an annular circulating passage is formed at the front end by the use of a plate beneath the front neck. This plate guides the cooler feed water around the shell, discharging it



beneath the furnaces at the front. The water is heated while passing around the furnaces and among the tubes, and enters the steam drum by the rear neck.

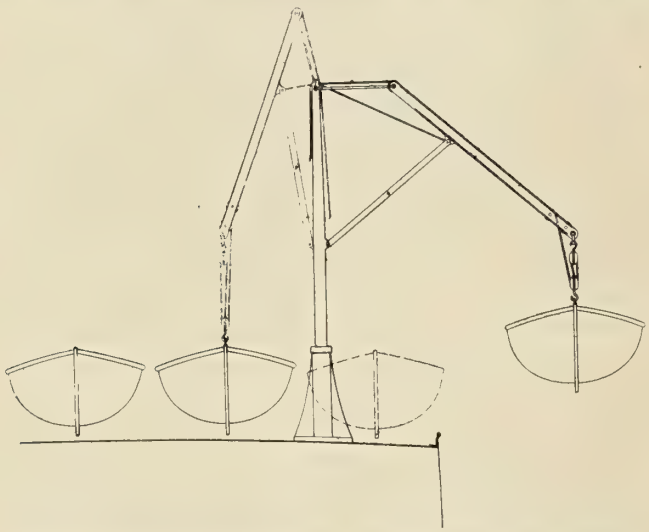
The claims for positive circulation, made by the builders, were thoroughly tested a short time ago at the Sewerage Pumping Station, Framingham, Mass. The Robb-Brady boiler at this plant was equipped with thermometer oil wells, so that the temperature could be noted at four points as follows: At the top of the shell near the front end, at the top of the shell at the rear just over the combustion chamber, at the front and rear close to the bottom.

With water in the boiler at about 80 degrees the fires were started and readings of all thermometers taken every five minutes. As was expected the temperature of the water at the top of the shell increased steadily until the boiling point was

reached. At the bottom the temperatures increased very slowly up to the time the upper thermometers indicated the boiling point. Then the lower thermometers showed a sudden rise; they jumped to within a few degrees of those at the top. From this time on all four kept within a few degrees until 100 pounds pressure was reached, at which time practically no difference could be noted at the four points, showing that the circulation was positive and rapid. The boiler is built under patents held by the Robb Engineering Company, Ltd., of South Framingham, Mass., and Amherst, N. S., Canada.

A New Type of Lifeboat Davit

A new type of davit, which involves some unusual features, has just been placed on the market by the McVeigh, Dougherty Derrick Supply & Equipment Company, Philadelphia, Pa. The davit is built to swing a boat loaded to its full capacity of passengers far enough from the ship's side to overcome the possibility of the boat's being smashed against the side of the vessel when launched in a rough sea. The davit has a reach as far inboard as it has outboard, so that after launching one boat it can reach back on the deck for the second and third, and launch them in succession as fast as they can be filled.



OUTLINE OF DAVIT REACHING INBOARD (DOTTED LINES) AND OUTBOARD (FULL LINES)

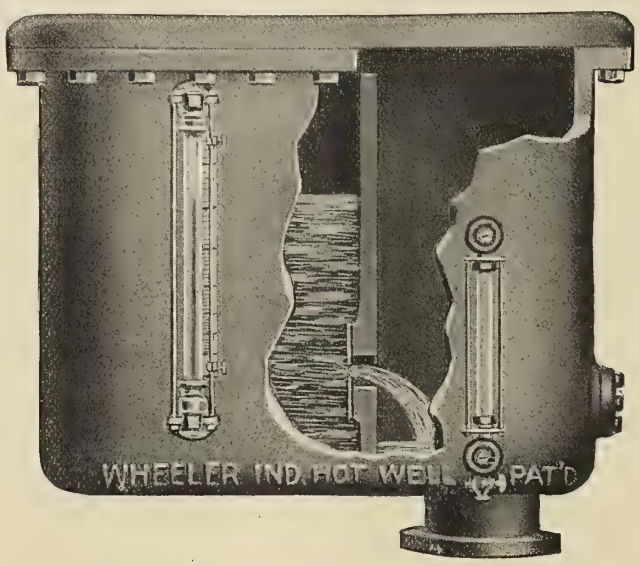
The reach of the davit also makes it possible to handle boats on the high side of a badly listed vessel.

As can be seen from the illustration the davit is simple in construction. It consists of a mast to which is attached a boom with a balanced cross-beam at its tip, which is fastened to the top of the mast by steel tie rods. The cross-beam turns on a pin bearing at about its middle point. To the other end of the beam is fastened a pulley, over which the cable for raising and lowering the boat is run. The load cable passes over a pulley near the upper end of the cross-beam, and thence to the mast and deck of the vessel. The beam is worked outward from the mast by means of a worm gear (not shown in the illustration), and is brought back again toward the mast by reversing the rotation of the screw. As this screw is short and is placed near where the mast and boom join, it makes it possible to move the davit out to its full reach by a few turns of the crank. If by accident this screw should break the davit will not fall with its load, as would be the case with an ordinary derrick, but the boom will drop only far enough to bring the load, the cross-beam, the connecting link and itself into a state of equilibrium.

One of the most important points about this arrangement of the davit is the fact that the boat remains at approximately the same level when the davit is being extended out to its extreme reach. Thus the load travels in a horizontal plane, and very little power is required for topping a load, as is necessary in an ordinary derrick. The reason for this is that the cross-beam tips down as the boom angle decreases, thus bringing about a saving in time and labor in manipulating the davit. All the work is done with boom angles of 45 degrees and less, so that the mechanism is very easy to handle. It is obvious that this type of davit takes up very little room on the vessel; that it can be handled rapidly, and, from its long reach, can launch several boats stowed side by side on the deck in a brief time regardless of the list of the ship.

A New Method of Measuring Steam Consumption

The steam consumed by a turbine or engine can be determined with absolute accuracy by weighing the "steam water" or condensate from a surface condenser. Very few plants have employed this method of measurement, due to the fact that ordinary weighing or measuring devices are costly and clumsy, and add not only extra expense but complicate piping, and withal are none too accurate. A simple, accurate and direct solution of the problem is presented in the indicating hot well, which is similar in size and appearance to the ordinary hot well, and is attached directly to the bottom of the



condenser, forming a part of the shell. This adds another valuable function to the equipment, which has for its purpose besides the maintaining of high vacuum that of providing pure distilled water for boiler feed, of heating this water to the highest feed temperature, and now the measurement of the amount of condensate and the rate of steam consumption of the engine or turbine.

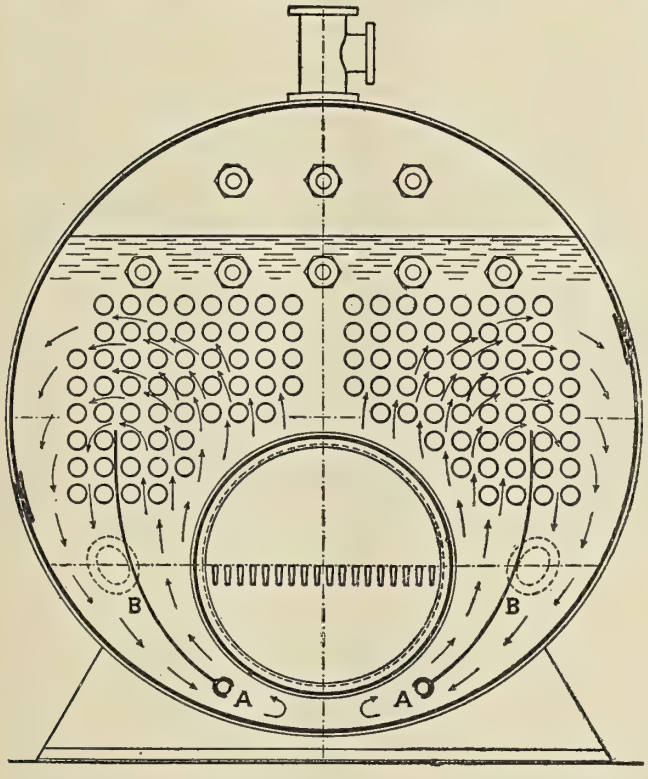
The indicating hot well is attached directly beneath the condenser. The opening in the bottom of the condenser is built so that the condensate drains into the left-hand chamber of the hot well, and communication from this chamber to the hot well pump suction is secured through an orifice in the dividing wall. The velocity of discharge through an orifice of given diameter varies directly as the square root of the head, and the quantity of water discharged is equal to the product of this velocity, the area of the orifice and the coefficient of contraction. With a properly designed orifice this coefficient remains almost exactly constant for widely different values of the head upon the orifice, and therefore the quantity of discharge is obtained with a high degree of accuracy by a carefully calibrated indicating gage glass, reading the head.

As may be seen from the illustration the orifice is formed in a brass plate inserted in the partition wall. It is polished

and finished to insure accuracy of flow. Especially manufactured fittings are used to attach the indicating gage to the shell of the hot well. Ball check valves are provided in each fitting, so that should the gage glass break the inflow of air will be prevented, and the gage glass can be replaced at leisure. A gage glass is also provided to show the height of the water in the hot well suction compartment, where the water must not be allowed to submerge the orifice. The scale attached to the indicating gage reads directly in pounds of steam per hour. Each orifice is made independently, carefully calibrated, and a special scale, etched upon steel, furnished for it. Over the whole range of readings the accuracy is claimed to be within 2 percent, and for readings from 75 percent to 125 percent load the accuracy is claimed to be within 1 percent. The indicating gage reads pounds of steam per hour; the station watt-meter gives load in kilowatts, and the rate of steam consumption in pounds per kilowatt-hour is obtained by simple division. This figure, entered regularly upon the engineer's log sheet and charted from day to day, is of the greatest importance in maintaining high plant economy. This device is manufactured by the Wheeler Condenser & Engineering Company, Carteret, N. J.

The Copeland Patent Automatic Circulating System

The automatic circulating system for Scotch boilers, patented by the F. T. Copeland Company, New York, consists of two rectangular plates of steel or other metal, of such length as to extend from head to head of the boiler, and of such width that when in position they will extend above and below the grate level or fire line. They are erected edgewise upon suitable means of support located below the grate line. The plates are curved to correspond approximately with the radius of the furnace. They are designed to reach from a point near

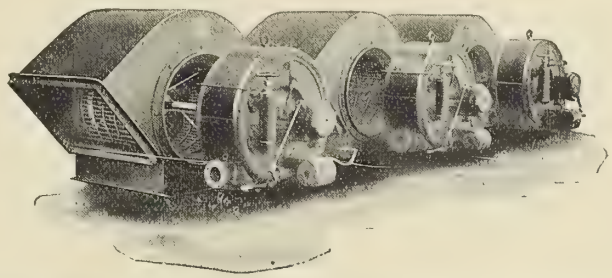


Tubes A A support plates B B and supply hot air to combustion chamber.

the center of the bottom of the boiler, to an indeterminate point above the bottom course of fire tubes. Tubes *AA* support plates *BB*, and incidentally supply hot air to the combustion chamber. Each plate becomes a partition which subdivides the space between the furnace and the shell, so that a pathway is provided for an uprising current on the inside, due to the heat from the furnace, and a down-flowing current on the outside, due to the greater density of the cooler water. Therefore it is claimed that the circulator establishes and maintains natural and complete circulation throughout the boiler; beginning immediately upon starting fires, and operating automatically and continuously until the fire is extinguished. The further advantages are claimed of increased horsepower capacity by causing the entire water contents of the boiler to travel over the heating surfaces; equalized temperature; improved combustion due to the admission of hot air to the combustion chamber, and improved boiler efficiency from the cleansing action of rapid circulation over the heating surfaces. This system can be applied to one, two, three or four furnace boilers.

A New Forced Draft Outfit

Unfailing constancy of operation has made the Terry turbine standard for running forced draft blowers. For use with a closed stoke hole system, the sets may either have a horizinal shaft with blower and turbine connected by flexible coupling, or they may be of the vertical type when required by torpedo boat destroyer or steam yacht practice. In the vertical sets the turbine is of standard single-stage type with the fan directly above it, and located on a line with the deck



at the foot of the ventilator. The whole unit is mounted on I-beams suspended from the deck to the bulkhead. The step-bearings as well as the turbine and blower bearings have forced lubrication.

The horizontal type is particularly compact and of light weight. There is no thrust in either the turbine or the fan. The wear on the rotating parts is small, as their only duty is to carry the weight of the light rotors. This type is free from such breakdowns as occur in high-speed fan engines from cracking cylinders or heads and water in the steam.

Particularly interesting are the three forced draft sets which have been furnished for the new Chinese training cruiser now under construction at the works of the New York Shipbuilding Company, Camden, N. J. These sets are located on the armor deck directly above the boiler room, and the air is discharged through openings in armor bar gratings in the deck. These sets occupy much less space than engine-driven units of the same capacity and only about half the head room.

Each turbine is designed for steam at 225 pounds initial pressure and back pressure of 10 pounds per square inch. The turbines are rated at about 60 horsepower, running at 1,220 revolutions per minute. Each is direct connected to a No. 5 double-inlet Sirocco fan of 30,000 cubic feet per minute against 3 inches static pressure. Each turbine is fitted with emergency governor, which comes into play and shuts down the machine in case the speed becomes excessive. They were furnished by the Terry Steam Turbine Company, Hartford, Conn.

Personal

H. McL. HARDING, consulting engineer for the design of terminal installations and freight-handling machinery, has removed his office to 17 Battery Place, New York.

THE COUNCIL of the Society of Naval Architects and Marine

Engineers elected on May 7 the following officers to fill existing vacancies in the organization of the society: Vice-presidents, Capt. A. P. Niblack, U. S. N., and George W. Dickie; members of Council, Commander L. N. Chandler, U. S. N., and Capt. C. A. McAllister, U. S. R. C. S.; associate member of Council, Henry S. Grove.

Obituary

ERNEST S. BOWEN, vice-president and general superintendent of the Fay & Bowen Engine Company, Geneva, N. Y., died April 27 from a severe attack of typhoid fever.

V. F. LASSOE, consulting engineer of the American-Hawaiian Steamship Company, New York, died May 22 of old age. He was born in Copenhagen, Denmark, in 1836, and began his business career in the United States with Mr. Ericsson, builder of the *Monitor*. For twelve years after the death of Mr. Ericsson, Mr. Lassoe was superintending engineer of the American-Hawaiian Steamship Company, and for the last year has been a consulting engineer for the same company. Mr. Lassoe was the inventor of the Lassoe system of fuel oil burning.

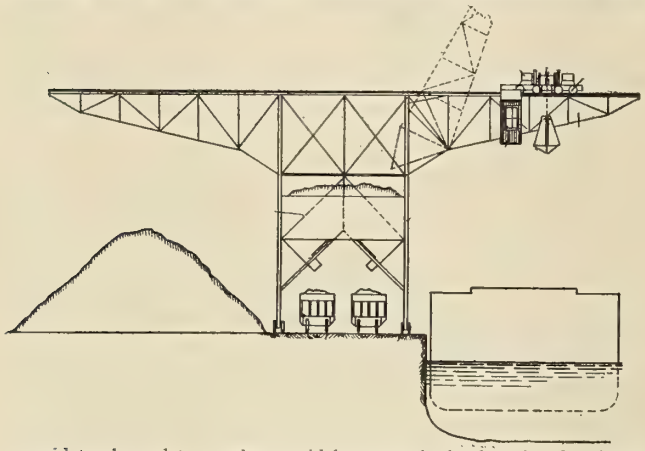
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,014,994. HANDLING, UNLOADING, STORING, AND RELOADING PLANT. HERMAN P. ANDRESEN, OF CHICAGO, ILLINOIS, ASSIGNOR TO DAVID J. EVANS, OF CHICAGO, ILLINOIS.

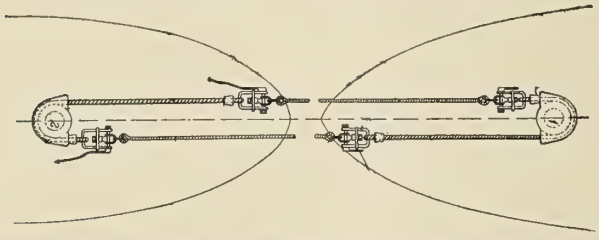
Claim 2.—The improvements herein described, comprising a storage dock having parallel stock pile spaces, in combination with tracks arranged at the dock front and between said spaces, a storage house at the landward side of said spaces, a traveling bridge constructed to travel



on said tracks and to overhang said house at the landward end, a hopper carried by the dock front end of the bridge, unloading means at said end of said bridge to deposit material in said hopper and a conveyer carried by said bridge for carrying material from said hopper to said house. Sixty-nine claims.

1,016,619. TOWING APPARATUS. LOUIS VICTOR WILLIAM FROGER, OF LORIENT, FRANCE.

Claim 1.—A towing apparatus for marine vessels comprising a cable in four parts, readily attachable and detachable connectors connecting said four parts into an endless cable, the cable being arranged with two of its parts extending between the towing boat and the towed boat sym-



metrically, and each of the other two parts of the cable being looped around fastening means on one of the boats and movable freely about said fastening means, thus tending to equilibrate the strains. Fifteen claims.

1,015,755. INVERTIBLE SCOW. WILLIAM E. COOK, OF ST. GEORGE, AND DANIEL HOWARD HAYWOOD, OF NEW YORK, N. Y.; FLORA G. HAYWOOD EXECUTRIX OF SAID DANIEL HOWARD HAYWOOD, DECEASED.

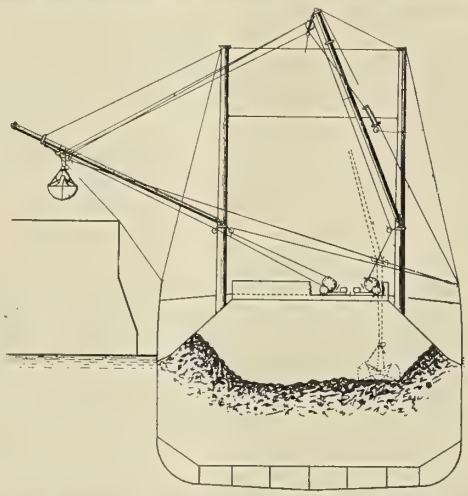
Claim 2.—An invertible scow having a water chamber therein, the upper portion of which is equally distributed upon opposite sides of a vertical longitudinal plane passing through the center of gravity of the vessel, the lower portion of which is unevenly disposed with respect to such longitudinal central plane, and means for admitting and discharging water to and from the said chamber. Five claims.

1,016,781. SAFETY DEVICE FOR SHIPS. WILLIAM S. SCARLETT, OF FALL RIVER, MASS.

Claim 1.—A safety apparatus for loading passengers into boats comprising a pair of davits with a block and tackle at each davit for connection with the ends of the boat, a collapsible safety conveyer and means intermediate the davits and independent of the block and tackle thereof for lowering the safety conveyer into the boat as held by the block and tackle of the davits, substantially as described. Two claims.

1,015,249. MARINE TRANSFER. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

Claim 1.—In marine transfer, a combination, a boat containing a hatchway, a pair of masts, a boom extending from one of the masts to a point above the hatchway, a hoisting rope sheave thereon, a second

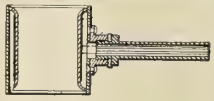


boom extending outboard from the other mast, an outhaul swinger rope sheave thereon, the swinger frame, the hoisting rope extending therethrough, the outhaul and inhaul swinger ropes and means for actuating the same. Thirteen claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

3,023. METHOD OF AND APPARATUS FOR OBSERVING MARINE CONDITIONS. H. T. BARNES, MONTREAL, CANADA.

Relates to apparatus for observing particularly the precise measurement of water temperature for ascertaining the presence of icebergs, shoals, etc. It has been suggested that icebergs might be detected by their cooling effect on the water, probably produced by water running from the berg, and spreading on the surface. Little use has been made



of this idea owing to the variable results obtained, since the thermometers in use could not read closer than one-tenth of a degree. With the new method and apparatus, temperatures can be accurately read to one-thousandth of a degree and continually recorded. The thermometer includes concentric tubes of heavy copper, with a space within which is the resistance coil having a resistance of one hundred ohms. The Wheatstone bridge method of measuring the resistance is used in conjunction with a Callendar recorder and Weston portable galvanometer.

18,854. SCREW AND LIKE PROPELLERS. A. J. MAHOUDTAU DE VILLETHIOU, PARIS.

In order to do away with the usual inoperative propeller boss which tends to impede progress, by this invention the propeller blades are supported at a distance from the shaft on a spiral mount which permits a free flow of water and is stated to give a much higher efficiency than the ordinary propeller.

19,123. BREATHING APPARATUS FOR USE UNDER WATER OR IN IRRESPIRABLE ATMOSPHERE. R. H. DAVIS AND SIEBE GORMAN & CO., LTD., LONDON.

The apparatus comprises a watertight chamber to surround the body and provided with a pocket to hold a chamber containing a substance producing oxygen gas and at the same time absorbing the carbonic acid gas of the breath exhaled by the wearer. The chamber has a pipe leading to the watertight chamber, and also a piece for fitting to the mouth. The watertight chamber is provided with a tube having a valve at its lower end. The wearer breathes in and out of the regenerating chambr so that the nitrogen originally in the chamber is retained, the oxygen used up being replaced by that given off in the chamber. Where the apparatus is employed under water, say in a damaged submarine, where water is entering, the water compresses the air within the submarine until the pressures balance. To prevent collapse of the hollow chamber the valve controlled tube is raised above the water level and the valve opened so that the air pressure within the chamber also becomes equal to that within the submarine. The valve is then closed. When the wearer leaves the submarine the valve is opened under water. The air in the chamber can then escape gradually as the wearer rises to the surface and the pressure decreases, so that the danger of the chamber bursting is obviated.